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REPORT

OF THE

Commissioner of Health

ON

ERRATA.

Page 6, line 26, for "would" read should.

Page 382, Appendix E, Paper 20. An explanation relating to this paper will be found at the head of page 358, entitled Appendix E, paper 18.

OF THE

CITY OF BROOKLYN.

JULY 3, 1883.

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REPORT

OF THE

Commissioner of Health

ON

ILLUMINATING GAS

MADE TO THE

COMMITTEE ON LAMPS AND GAS OF THE COMMON COUNCIL

OF THE

CITY OF BROOKLYN.

JULY 3, 1883.

Department of Health,
Brooklyn, July 3, 1883.

To the Honorable the Committee on Lamps and Gas of the Common Council:

Gentlemen :

I respectfully submit the results of an inquiry into the relative danger of water gas and coal gas, and the analysis of each as requested by you in a communication received April 6, 1883, a copy of which is subjoined—together with other information which was received in the course of the investigation.

J. H. Raymond, M. D., *Commissioner of Health of Brooklyn :*

Dear Sir :

The following preamble and resolution, introduced in the Common Council on Monday, March 26, 1883, by Ald. Houghton, was referred to the Committee on Lamps and Gas in connection with yourself :

Whereas, The recent introduction in the pipes and mains of several old established coal gas companies in the city of what is known as naphtha or water gas, manufactured by the Fulton Municipal Gas Company, has forced, without warning, upon our citizens in the districts controlled by these companies, the use of a gas exceptionally poisonous and dangerous to health and life, and,

Whereas, The heretofore limited use of naphtha or water gas in this city has caused the death of no less than eight persons within the past two years, and in the city of New York over fifty deaths are recorded as caused by this gas, while on the other hand no record can be found of the death of a single individual caused by coal gas since its introduction in Brooklyn in 1849, and only one in the city of New York, and,

Whereas, After a most thorough investigation by eminent and disinterested scientists in the city of Boston in 1878, the use of this gas or any gas containing more than ten per cent

of carbonic oxide was, by law, in the year 1880, prohibited in the State of Massachusetts, and in the State of New Jersey the law is still more stringent; and,

Whereas, Naphtha, or water gas, as manufactured by the Fulton Municipal Company and supplied to the Citizens', Metropolitan and People's Gas Companies of this city, is said to contain about thirty (30) per cent. of carbonic oxide, which is known as a rank poison; therefore, be it

Resolved, That the Commissioner of Health of the city of Brooklyn be and he hereby is authorized and directed to investigate the matter and cause an analysis of the gas manufactured by the Fulton Municipal Gas Company of Brooklyn to be made, together with the number of deaths caused by this gas since its introduction, and report to this Common Council within thirty days.

Amended to include coal gas.

The undersigned, members of the Committee on Lamps and Gas, do request that you cause to be made an analysis of what is known as water gas, manufactured by the Fulton Municipal Gas Company of Brooklyn, of coal gas manufactured by the Brooklyn Gaslight Company, and investigate to what extent the use of water gas is more dangerous to public health and life than is the use of coal gas.

We also request that you cause to be compiled a list of all deaths caused by the inhalation of illuminating water gas in the city of Brooklyn and in the city of New York since its introduction in 1878, also a list of all deaths caused by the inhalation of illuminating coal gas since its introduction in Brooklyn in 1849, and in New York since 1878, together with the proportion of each gas used in New York and Brooklyn within the above period, and in what States of the Union has the use of water gas or any gas containing more than ten per cent. of carbonic oxide, been prohibited by law, and report to this Committee at your earliest convenience.

Yours respectfully,

GEORGE H. STERLING, ROBERT HILL, OWEN E. HOUGHTON, PHILIP CASEY.	*Committee on Lamps and Gas.*

This communication calls upon me to report to you upon the following particulars:

A.—Analysis of water gas and coal gas.

B.—List of deaths from the two gases in Brooklyn and New York.

C.—The production of each kind of gas in New York and Brooklyn.

D.—The prohibition of water gas by law ; and,

E.—An opinion as to the relative dangerous properties of the two kinds of illuminating gas.

"A." ANALYSIS.

In procuring the analysis of the two gases it was my aim to have the aid of a chemist of national or very wide reputation, and one who had not formerly been identified with any similar investigation. Very fortunately, I was enabled to secure the services of Professor Ira Remsen of the John Hopkins University. His report is as follows :

John Hopkins University,
Chemical Laboratory,
Baltimore, May 8, 1883.

J. H. Raymond, M. D., *Commissioner of Health, Brooklyn, N. Y.*

Dear Sir :

In accordance with your request I have analyzed specimens of the two kinds of illuminating gas manufactured and used at the present time in the City of Brooklyn. The specimens were collected from house fixtures in the city, and were received by me in hermetically closed bottles. I herewith send the result of the analyses, together with a statement concerning the probable danger to life and health connected with the use of the two kinds of gas for illuminating purposes.

Specimen marked "A" (coal gas), was found to have the composition expressed in the subjoined table:

	PER CENT.
Carbon dioxide (carbonic acid)	0.0
Illuminants (ethylene, &c.)	4.3
Carbon monoxide (carbonic oxide)	7.9
Hydrogen	50.2
Marsh gas	29.8
Nitrogen (by difference)	7 8
	100.0

The composition of the specimen marked "B" (water gas), is here given.

	PER CENT.
Carbon dioxide (carbonic acid)	0.3
Illuminants (ethylene, &c.)	12.85
Carbon monoxide (carbonic oxide)	28.25
Hydrogen	30.3
Marsh gas	21.45
Nitrogen (by difference)	6.85
	100.00

Concerning the question of the danger to health resulting from the use of these gases, it is, of course, known that the principal dangerous constituent is carbon monoxide (or what is commonly called carbonic oxide.) Both these gases contain considerable quantities of this constituent.

Both, if inhaled, would produce bad effects, and, if inhaled to a sufficient extent, both would cause death. I do not think, however, that the difference in the per centages of the monoxide present in the two gases is a matter of any importance from a sanitary standpoint. Whether one gas or the other is used, there is danger connected with its escape, in unburned condition, into rooms occupied by human beings. But long before enough of either to produce bad effects could accumulate in a room, it would necessarily be detected by its odor, for both specimens submitted to me had, as far as I could judge, equally bad odors.

In case the occupants of the room would be asleep at the time of the escape of the gas, it is possible that a fatal effect might be reached a few minutes earlier in the case of water gas than in that of coal gas, but it is highly improbable that, in either case, there could be a leak in the pipes sufficiently bad to lead to serious results without attracting attention during the waking hours.

My opinion may be briefly stated thus:

I do not consider the use of water gas at all dangerous, if it be used with the same precautions as are observed in the use of ordinary coal gas.

Yours respectfully,

IRA REMSEN.

All due care was taken in the procuring of samples of gas for analysis, and in the sending of the same to Baltimore. The kind of gas was designated in no wise other than by the letters "A" and "B." "A" being a specimen of coal gas, and "B" one of water gas.

"B." THE LIST OF DEATHS IN BROOKLYN AND NEW YORK CITY BY BOTH COAL AND WATER GAS.

The reports of deaths by gas poisoning in these two cities have been examined into most carefully by reference to all the available original records. In respect of Brooklyn, all the death certificates on file in the Health Department have been examined for the purpose of discovering every death for which gas was responsible; the reason primarily for this exhaustive examination was that only during recent years has the record of causes of death been so prepared as to show definitely that gas was or was not the cause of death.

In former years very many deaths were registered as due to suffocation or asphyxia without describing the agency by which this fatal termination was brought about.

Further, all the coroners' inquest papers in the County Clerk's office bearing upon cases of death by suffocation were examined for the purpose of verifying the mortality records on file in the Health office. In this inquiry more than 300,000 papers of official record have been examined, with the result of enabling me to present as full and as accurate a record of deaths and injuries from both kinds of gas as it is possible to make.

In the subjoined table are given the total deaths by illuminating gas in the two cities, also the cases of injury, not fatal, due to illuminating gas in Brooklyn. It was found impossible to obtain any reliable information of injuries from gas in New York city, except in those cases which proved fatal, and they are therefore not included in this summary. Numerous cases have been attributed to illuminating gas, and in the appendix to the report will be found a large number of such taken from newspapers and pamphlets.

Cities.	Water Gas.		Coal Gas.	
	Deaths.	Injury not fatal.	Deaths.	Injury not fatal.
Brooklyn	8	13	3	....
New York	44	....	21	....

The following list contains all the deaths and injuries from illuminating gas which can be ascertained to have occurred in Brooklyn since the introduction of gas in 1849, and the deaths which have occurred in New York city from the same cause since 1866, at which time accurate records were first made in that city. There will also be found some cases which have been attributed to illuminating gas, but which upon investigation have been ascertained to be due to other causes. It will be noticed that each case has a number. This refers to the detailed history of the case so far as it was obtainable, and which will be found immediately after the table. The histories are given as they appear in the official records, and where dates and other important matter are wanting it is due to the imperfect record.

CASE 1. BROOKLYN.

Testimony taken before the Coroner, October 6, 1869. Fred. Clark, age sixteen years. — Myrtle avenue, in the Twenty-first Ward.

Verdict: That said Fred. Clark came to his death by accidental suffocation from the effects of gas.

Testimony: Wm. H. Clark, being produced and duly sworn and examined, testifies and says that: The deceased was my brother. On October 6 he retired to bed about 10 o'clock P. M., and was found about 7 o'clock A. M. on the morning of the 7th suffering from the effects of gas which had escaped into his room from the gas burner, through the same not having been properly turned off; called in a physician, who said that the escaped gas had produced asphyxia of suffocation.

WILLIAM H. CLARK.

CORONER'S CERTIFICATE OF DEATH.

This is to certify, that I, L. A. Whitehill, Coroner in and for the county of Kings, have this, the 7th day of October, 1869, viewed the body of Fred. Clark, who died at — Myrtle avenue, in the Twenty-first Ward of the city of Brooklyn; that I have held an inquest upon the said body, and that the verdict of the jurors is, that he came to his death by accidental suffocation from the effects of gas.

L. A. WHITEHILL,

[L. S.] *Coroner.*

Case No.	Name.	Date of Accident.	Location.	Age.	Result.	Kind of Gas found by this Investigation.	Remarks.	Authority.
1	Fred. Clark	October 6, 1869	Myrtle avenue, Twenty-first Ward	16 years	Fatal	Illuminating Coal Gas	Gas-cock not turned off	Coroner.
2	William Bullock	April 17, 1880	Fulton Municipal Gas Works		Not fatal	Illuminating Water Gas	Inhaled gas from 20-inch pipe	President, Fulton Municipal Gas Company.
3	Peter Quinn	April 17, 1880	Fulton Municipal Gas Works		Not fatal	"	Inhaled gas from 20-inch pipe	" " "
4	....	November 15, 1880	Corner Fulton and Oxford streets		Not fatal	"	Inhaled gas while connecting mains	" " "
5	Frank Barnes	December 5, 1880	179 Duffield street		Not fatal	"	Stop-cock turned too far, no check	Dr. B M Briggs.
6	Henry Egan	December 5, 1880	179 Duffield street		Not fatal	"	Stop-cock turned too far, no check	" "
7	Matilda A. Hogfeldt	April 15, 1881	296 Sackett street	24 years	Fatal	"	Leaking gas pipe	Coroner.
8	Patrick Cook	July 11, 1881	Fulton Municipal Gas Works.	57 years	Fatal	"	Combined fall and inhalation of gas	"
9	John Agins	October 13, 1881	Clinton House, 256 Fulton street	22 years	Fatal	"	Blew out the gas	"
10	Nina Lawson	October 15, 1881	49 Tompkins place		Not fatal	"	Stop-cock open	Mistress of house.
11	Julia Neilson	October 15, 1881	49 Tompkins place		Not fatal	"	Stop-cock open	"
12	John W. Chevalier	March 7, 1882	17 Red Hook lane		Not fatal	"	Making house connection	John W. Chevalier.
13	A. H. Baldwin	April 14, 1882	Pierrepont House, Montague street		Not fatal	"	Blew out the gas	Proprietor of Hotel.
14	W. King	May 13, 1882	Clinton House, 256 Fulton street		Not fatal	"	Stop-cock open	"
15	Theodore Hartke	October 9, 1882	Annex Hotel, 1 Fulton street	23 years	Fatal	"	Blew out the gas	Coroner.
16	William Hueske	October 9, 1882	Annex Hotel 4, Fulton street	26 years	Fatal	"	Blew out the gas	"
17	Susan E. Fendick	October 28, 1882	111 Fort Green place	19 years	Fatal	"	No check on stop-cock of fixture	"
18	Hannah C. Johnson	March 15, 1883	215 Graham street	79 years	Fatal	"	Stop-cock open	"
19	Mary Reilly	March 15, 1883	230 Livingston street		Not fatal	"		Dr. B. M. Briggs
20	Ann Reilly	March 15, 1883	230 Livingston street		Not fatal	"		" "
21	John A. Hanf	May 10, 1883	128 Rutledge street	77 years	Fatal	"	Stop-cock turned on	Coroner.
22	Patrick Creighton	September 30, 1882	Clinton near Second place		Not fatal	"	Stop-cock turned on	Dr. McEvitt.
23	Thomas Wallace	January 24, 1882	362 Pearl street	71 years	Fatal	Illuminating Coal Gas	Defective gas stove	Coroner.
24	Susanna M. Wallace	January 24, 1882	362 Pearl street	61 years	Fatal	"	Defective gas stove	"

Supplemental List of Deaths and Injuries NOT due to Illuminating Gas, but by some Reports charged to Illuminating Gas.

Case No.	Name.	Date of Accident.	Location.	Age.	Result.	Kind of Gas found by this Investigation.	Remarks.	Authority.
25	Alfred Russell	March 25, 1854		4 months	Fatal	Noxious Gas	Nothing additional ascertained	Coroner.
26	John Heeney	April 11, 1863	87 Carlton avenue	19 years	Fatal	Gases of Decomposition	Privy vault	"
27	James McGee	February 25, 1867	Harper's Court	30 years	Fatal	Carbonic Acid Gas	Distillery vat	"
28	John McCarron	February 24, 1870	38 Bridge street	26 years	Fatal	Stove Coal Gas		"
29	Mrs. John McCarron	February 24, 1870	38 Bridge street		Not fatal	"		"
30	Mary J. Norton	March 27, 1872	196 Raymond street	59 years	Fatal	"	Defective furnace	"
31	Oliver S. Vincent	June 21, 1878	Municipal Building	35 years	Fatal	Illuminating Coal Gas	Explosion	"

RECAPITULATION FOR BROOKLYN.

Illuminating Coal Gas	4
Illuminating Water Gas	21
Stove Coal Gas	3
Other Gases than Coal or Illuminating	3
Total	31

D) with
Coal gas 3
Wat gas 8

CASES 2, 3 and 4. BROOKLYN, May 17, 1883.

In reply to your communication of May 10, I state the following facts as to the cases you refer to.

On or about the date mentioned, April 17, 1880, two men (not four), were temporarily overcome by gas in a cellar at our works, late in the day. One man (Bullock), recovered in a few hours, and remained at the works. The other man (Quinn), was taken to the Long Island College Hospital, but was discharged the next morning, and came directly to the works and resumed his duties, as did also William Bullock. The latter is now in our employ, and Peter Quinn is now working in New York city. Neither complained of any ill effects afterward. The test was a severe one, as an immense quantity of gas escaped into the cellar, which was deep and poorly ventilated, and the pressure of the gas being direct from the gas holders, was very great.

The cause of the accident was as follows:

A man employed by a contractor (for the works were not entirely finished), loosened an iron hand hole plate on a 20-inch pipe, not knowing that the gas was turned on that pipe. In his fright he dropped the iron plate and ran upstairs, leaving the gas pouring through an opening six inches in diameter. The two men who were overcome went down to try and replace the iron plate, but stayed too long, and had to be taken out by others. Both recovered, as stated, and were around next day.

At Fulton and Oxford streets, November, 1880, one man (not two), was partially overcome by escaping gas while at work for this company in making a pipe connection. He recovered in about an hour and resumed his work the same afternoon, with no ill effects afterwards. He is now in our employ. The cause of the accident was the improper handling of the tools, allowing a large quantity of gas to escape—the men having been but recently employed (at that time) by our company, and not well accustomed to the work.

Respectfully yours,

H. M. BENEDICT,

Fulton Municipal Gas Co., 342 Fulton Street.

CASE 3.

THE LONG ISLAND COLLEGE HOSPITAL,
Henry Street, between Pacific and Amity Streets,
BROOKLYN, N. Y., May 11, 1883.

I find upon our record the name of Peter Quinn, entered April 16, 1880, and discharged April 17. Diagnosis—scalp wounds. He was a steam fitter. The clinical record books contain no mention of the case.

Yours truly,

A. H. BROWN.

CASES 5, 6, 19, 20, 23 and 24.

Having had opportunity to see the practical action of coal gas and so-called water gas on the human system, as met with in actual practice in several cases, I submit the facts to the Department.

First.—Was called hurriedly to 179 Duffield street, about 5.30 A.M., found two young men unconscious and in convulsions. It was in the month of December, a cold night, and all apertures of the room to which they had retired were closed, so that a window had to be forced open when the servant alarmed the house, from the smell of escaping gas. They had retired at about 12 o'clock, and turned an old fixture too far around. As the treatment was the same in all the cases, I will not spend time on it, but say that both young men recovered perfectly, one in three days, the other, who was frail, in about three weeks. These parties had inhaled water gas.

Second.—Hurriedly called to 362 Pearl street, by police; found old lady dead and husband insensible by her side; small gas stove on the floor; had been burning coal gas with incomplete combustion. The old man, who was naturally tough and wiry, revived under treatment, became somewhat intelligent, conversed with those about, partook of light food, but died that evening of "coal gas poisoning," not asphyxia or exhaustion.

Third.—Was called about 6 A. M. to two girls at 230 Livingston street, who had retired about 10 P. M., and left the gas fully on, having probably turned it off and on again. Found them both limp, cold and insensible; within a short time one was able to walk up stairs, the other being carried; by 11 A.M. they were almost restored, with eyes, pulse and skin favorable, but sleepy. When visited in the afternoon had taken nourishment and complained only of slight headache; in the morning they were fully recovered and were able to attend to their usual duties. The gas used on the premises was water gas.

As the gas was turned on full and there was a stove in actual combustion in the room, there appears to be little danger from explosion from water gas.

Conclusion.—Of six cases seen about the same morning hour, two died from the effects of coal gas, and four recovered from the effects of water gas.

BENJ. M. BRIGGS, M. S., M. D.

106 Willoughby street, cor. Duffield street, Brooklyn.

CASE 7.

Evidence taken at 296 Sackett street on April 15, 1881, as to the cause of death of Matilda Augusta Hogfeldt. Being duly

sworn, Daniel Ferry deposes and says: I am an officer of police stationed at the Third Precinct Station House. I was sent from the station house to 296 Sackett street this morning at about 6.25 A.M. I found the deceased lying on the side of her face on the floor; there was a strong odor of gas in the room, the window and the door were both open at the time; gas was not burning; I did not examine the fixtures.

[Signed], DANIEL FERRY.

Frank Winne, sworn, says: I reside at 296 Sackett street, am seventeen years of age. Knew the deceased; have known her four days, during which time she has been in my mother's service. I went downstairs this morning at about 6.30 to get my breakfast; the deceased, however, was not there. I came up and told my mother and she told me to go up stairs and wake up the girl. I went up, knocked on the door, called for her but received no answer; finally I came down, told my mother that I could receive no answer. I fetched a key and opened the door, which was locked. I then saw her lying on the floor next to the bed in an apparently lifeless condition; there was a strong smell of gas in the room; the gas was burning in full flame at the time, but not below it; I wanted to turn off the gas, but my mother told me not to do so; I then went to the police station; on the street I met Mr. Spies, told him of the occurrence and he came in the house.

[Signed], FRANK WINNE.

Anton G. Spies, being duly sworn, says: I reside at 289 Sackett street. I met Frank Winne in the street at about six o'clock this morning; he told me to go across the way to his mother to keep her company, that the servant had died during the night; I came right over; I went up stairs; I found a strong leak of the gas on the top floor; in going into the girl's room I found a still stronger smell of gas in the room —the gas burning; the tap of the other gas jet was closed; I turned off the burning light and opened the windows; the girl was lying on the floor face downwards in a dead condition; her limbs were stiff, her face, however, was warm; the ambulance surgeon arrived soon after and pronounced her dead.

[Signed], A. G. SPIES.

Mary A. Winne, being sworn, testified and says: I reside at 296 Sackett street: deceased was in my employ since last Monday as a servant; her name is Matilda Hogfeldt, as near as I can remember; she was apparently well last evening, went

to bed unusually early; this morning at about half past six my son came into my room and told me that the girl was not downstairs; I told him to go up stairs and wake her up; he went and came back and told me that he could receive no answer; I told him to go up and open the door and wake her; he came back and told me that the door was locked; I proceeded up stairs; first I knocked at the door but received no answer, we then looked for a key, found one that opened the door, and found her lying on the floor on her face: the gas was burning bright; windows closed; strong smell of the gas in the room; I sent my son for a policeman and left the room; the girl generally had a candle and was not to use the gas.

[Signed.] MARY A. WINNE.

CORONER'S CERTIFICATE OF DEATH. (4,135.)

This is to certify that I, Ferdinand Keller, M. D., Coroner in and for the county of Kings, have this, the 15th day of April, 1881, viewed the body of Matilda Augusta Hogfeldt, who died at 296 Sackett street, in the Sixth Ward of the city of Brooklyn; that I have held an inquest upon the said body, and that the verdict of the jurors is, that she came to her death by suffocation from gas, which was caused to escape from a leak in a gas pipe in deceased's room, on the 15th day of April, 1881.

1.—Full name, Matilda Augusta Hogfeldt.
2.—Age, twenty-four years.
3.—Sex, female.
4.—White.
5.—Single.
6.—Birthplace, Sweden.
7.—Occupation, domestic.
8.—If of foreign birth, how long in the U. S., 11 months.
9.—How long resident in city, 11 months.
10.—Father's birthplace, Sweden.
11.—Mother's birthplace, Sweden.
12.—Place of residence, No. 296 Sackett street, Brooklyn, Sixth Ward.
13.—Number of families in house, one.
14.—On what floor, third.
15.—Place of inquest, 296 Sackett street.

J. KELLER, M. D.
[L. S.] *Coroner.*

Place of burial, Evergreen Cemetery.
Date of burial, April 16, 1881.
Undertaker, J. H. Huntington; place of business, Atlantic St.

CASE 8.

Testimony taken before Coroner Keller at 96 William street, as to cause of death of Patrick Cook.

A. W. Shepard, M. D., being sworn, says:

That I am a regular practising physician and surgeon. I reside at 126 Willoughby street, in connection with Doctors Leuf, Bunker and Westbrook. I made a post mortem examination of the body of Cook at 96 William street, July 11, 1881. Found an abrasion of the right ear and right temple, the nasal bones and nasal process of frontal bone were fractured and comminuted. On opening the skull noticed the bright red color of the blood and its fluid condition. No unusual congestion of the brain. No fracture of the skull. Opened the chest and found the left pleura firmly adherent and ossified at points, here as in the brain. In the heart, liver, lungs, &c., the blood remained fluid, and maintained the bright red color observed everywhere. Kidneys, liver, heart, and in fact all the organs were quite healthy. In my opinion death resulted from the combined effects of concussion of the brain from the blow upon the nose, which must have been produced by a fall from a height, together with blood poisoning from the inhalation of the gas.

[Signed], A. W. SHEPARD, M. D.

William Bullock, sworn, says:

I reside at 559 Sackett street. Knew deceased. Am employed by the Fulton Municipal Gas Co. as foreman. Deceased was under my superintendence. His duty was in the governor house. It is the house where the gas is changed from one house to another, and where the pressure upon the gas in the streets is regulated. There are pumps in the cellar which are used for pumping off the condensation of the gas. Deceased's duty was to go down in the cellar and do the pumping. I came down in the cellar immediately after deceased was found, and assisted in carrying him up. He was dead then. There was a little more smell of gas than usual, but nothing more than a man could stand. I made an examination that same evening of the cellar, and found no perceptible leak.

[Signed], WILLIAM BULLOCK.

John Cooney, sworn, says:

That I reside at 588 Sackett street. Am employed by the Fulton Municipal Gas Co. Knew deceased. He was employed by said company in the same capacity as I was. He

was employed in the same part of the works with me—in the governor house. His duty was to see to the governor, the gas regulator, and to pump the trips. The two trips are down in the cellar, and deceased was compelled to go down in the cellar to do the pumping. On Saturday last, July the 9th, 1881, I last saw him when he relieved me from my work. I returned to my work at a quarter of 6 o'clock. When I went into the house I did not see him upstairs, so I went down in the cellar, presuming he must have been down there to pump the trips. When I arrived at the foot of the stairs deceased was lying on his back. He was dead, as I thought. I saw a small scratch on his nose. I picked him up and brought him in the office with the assistance of another man. The height from the floor to the cellar where deceased was found was about 8 or 10 feet. When I went down there was not stronger smell than usual. There always is a smell of gas there when the trips are pumped.

his
JOHN x COONEY.
mark.

Augustus Bullock, sworn, says:

I reside at 559 Sackett street. Was employed by the gas company in question at the time of the accident to paint the tank. Knew the deceased Patrick Cook. Last saw him alive on July 9, 1881, at a quarter after 5 o'clock. He was then speaking to me on the grounds, and from there he went into the governor, and next I saw him about a quarter of 6 o'clock, when he was carried up dead.

[Signed], AUGUSTUS BULLOCK.

CORONER'S CERTIFICATE OF DEATH. (7,645.)

This is to certify that I, Ferdinand Keller, M. D., Coroner in and for the County of Kings, have this, the twelfth day of July, 1881, viewed the body of Patrick Cook who died at Nevins and Degraw streets, in the Tenth Ward of the City of Brooklyn: that I have held an inquest upon the said body, and that the verdict of the jurors is, that he came to his death by concussion of the brain from a blow upon the nose, received from an accidental fall from the ground floor of the governor house of the Fulton Municipal Gas Co. to the cellar, together with blood poisoning from the inhalation of gas while lying in said cellar, 9th day of July, 1881.

1.—Full name, Patrick Cook.
2.—Age, fifty-seven years.

3.—Sex, male.
4.—White.
5.—Married.
6.—Birthplace, Ireland.
7.—Occupation, laborer.
8.—If of foreign birth, how long in the United States, thirty-one years.
9.—How long resident in city, thirty-one years.
10.—Father's birthplace; Ireland.
11.—Mother's birthplace, Ireland.
12.—Place of residence, No. 96 William street, Brooklyn, Twelfth Ward.
13.—Number of families in house.
14.—On what floor.
15.—Place of inquest, 96 William street.

F. KELLER,
[L. S.] *Coroner.*

Place of burial, Holy Cross.
Date of burial, July 12, 1881.
Undertaker, J. E. Newman.
Place of business, 125 King street.

CASE 9.

Testimony taken at Long Island College Hospital on October 13, 1881, as to the cause of death of Robert Agins.

I am house physician at the Long Island College Hospital; the deceased was admitted to the hospital October 12, 1881, suffering from poison from carbureted hydrogen gas; he was treated here until his death, October 13, 1881, at 1.30 A. M., and in my opinion death resulted from poisoning due to the inhalation of gas.

[Signed], . J. T. MORTON, M. D.

Wesley M. Neiblock, sworn, says: I reside at 256 Fulton street; I am the proprietor of the Clinton House, at that place, a house where I keep transient and other boarders. On Sunday night, October 9, 1881, the deceased man lying here came at about 8.30 A. M. and applied for a night's lodging and paid for it in advance; I registered his name as Robert Agins, of Lucerne, New York; he was assigned to room 45, on the third floor, and after the room was opened he went to his room, which was at 8.30 or 9 o'clock. On Monday morning, October 10, 1881, at about 10 o'clock, Margaret Merwan, one of the chambermaids, came down and told me she thought a man in room 45 was dying.

The porter went up at my direction, and I followed, and I sent for a doctor, who treated him until yesterday, when he was taken to the hospital in an ambulance.

[Signed], W. M. NEIBLOCK.

Margaret Merwan, sworn, says: I reside in the Clinton House and am one of the chambermaids. On Monday morning last, October 10, 1881, at about ten o'clock, I passed through the hall of the Clinton House, on the third floor, when I smelled the odor of gas coming from room 45. I rapped at the door, which was locked, but received no answer; only heard moaning. I then went to the office and reported it to Mr. Neiblock; he sent the porter with me and we went up together. The porter burst in the door and opened the windows in the room, as the odor of gas was very strong; on the bed a man was lying moaning; the gas was open and gas was escaping from the jet, and the porter turned off the gas; the man said nothing.

[Signed], MARGARET MERWAN.

John Curry, sworn, says: I reside at the Clinton House, and am a porter there. On Monday morning last, at about ten o'clock, I was sent by Mr. Neiblock to room 45; I knocked at the door first, but received no answer; I smelled the odor of gas in the hallway; I tried to unlock the door with a key but did not succeed, and therefore I burst in the door. I found a strong smell of gas in the room and the windows closed; I opened them, found that the gas was turned on fully and was escaping; I turned off the gas; a man was lying on the bed; the man was unconscious and moaning, lying on his bed, and said nothing; the man was taken away yesterday at about 11 o'clock; newspapers were on the bed; the man lying here is the man I have reference to.

[Signed], JOHN CURRY.

Moses Thompson, sworn, says: I reside at Lucerne, New York; I came here for the purpose of taking care of deceased during his illness. Deceased's name is Robert Agins; he is twenty-two years of age, single, and from Lucerne, and is a painter by trade; he left Lucerne a week ago last Tuesday, and came to Brooklyn to get a job.

[Signed], MOSES THOMPSON.

F. KELLER, M. D., *Coroner.*

Coroner's Certificate of Death. (12,377.)

This is to certify, that I, Ferdinand Keller, M. D., Coroner in and for the County of Kings, have this, the 13th day of October, 1881, viewed the body of Robert Agins, who died at Long Island College Hospital, Henry street, in the Sixth Ward of the City of Brooklyn; that I have held an inquest upon the said body, and that the verdict of the jurors is, that he came to his death by poisoning due to the inhalation of gas, he having blown out the gas in his room in Clinton House, on the 13th day of October, 1881.

1.—Full name, Robert Agins.
2.—Age, twenty-two years.
3.—Sex, male.
4.—White.
5.—Single.
6.—Birthplace, United States.
7.—Occupation, painter.
8.—If of foreign birth, how long in the United States—
9.—How long resident in city—
10.—Father's birthplace, Ireland.
11.—Mother's birthplace, Ireland.
12.—Place of residence, Lucerne, New York.
13.—Number of families in house—
14.—On what floor,
15.—Place of inquest, Long Island College Hospital.

F. KELLER, M. D.,

[L. S.] *Coroner.*

Place of burial, Lucerne, N. Y.
Date of burial, October 15, 1881.
Undertaker, John C. Kuhlke,
Place of business, 148 Court street.

CASES, 10 and 11.

Nina Lawson and Julia Neilson, residing at 49 Tompkins place, retired on the evening of October 15, 1881, at 11 o'clock. Their mistress smelling gas at about 5.30 o'clock in the morning, traced it to the girls' room, and when admission was obtained, found both girls prostrated; one (Nina Lawson) unconscious and the other semi-conscious. A physician was summoned and the girls were cared for and recovered. All the apertures through which air could find admission in the room, and the gas egress, were closed with paper. I was informed

by the lady of the house that the girls undoubtedly did this to hide the light and prevent it being seen in the halls, so that she would suppose they had gone to bed. The girls are now in good health and reside in Brooklyn.

W. J. CRUIKSHANK, M. D.,
Inspector.

CASE 12.

BROOKLYN, May 17, 1883.

In reference to case of water gas suffocation of March 7, 1882, I would like to say that the undersigned is the party alluded to, and the following is a true statement as to the facts of the case :

In making a gas connection in a dwelling in Garden place, my position was so cramped that the escaping gas overcame me for a moment. I was able, however, to walk to 17 Red Hook lane, to which place some officious person had an ambulance called. The doctor in charge said there was no occasion for his services, nor was there, as I soon got rid of my headache, and have never since had any re-occurence. I can only add that I am subject to headaches, and the smell of the gas merely aggravated the tendency on that occasion. In fact, I considered the matter as of no importance whatever.

Very respectfully,

JOHN W. CHEVALIER.

CASE 13.

A. H. Baldwin took a room at the Pierrepont House, Montague street, Brooklyn, April 14, 1882. He was found unconscious in his room, but was resuscitated in twenty minutes. The gas was blown out by him.

CASE 15.

Theo. Hartke, Hueske's companion. The evidence in this inquest is contained in the inquisition papers of William Hueske, who died at the same time and under the same circumstances.

J. KELLER, M. D.,
Coroner.

CORONER'S CERTIFICATE OF DEATH. (12,804)

This is to certify, that I, Ferd. Keller, M. D., Coroner in and for the County of Kings, have this, the 10th day of October, 1882, viewed the body of Theodore Hartke, who died at 14 Fulton street, in the First Ward of the city of Brooklyn; that

I have held an inquest upon the said body, and that the verdict of the jurors is, that he came to his death by suffocation from illuminating gas, having blown out gas in room on the 9th day of October, 1882.

1.—Full name, Theodore Hartke.
2.—Age, twenty-three years.
3.—Sex, male.
4.—White.
5.--Single.
6.—Birthplace, Germany.
7.—Occupation, laborer.
8.—If of foreign birth, how long in the United States, six months.
9.—How long resident in city, six months.
10.—Father's birthplace, Germany.
11.—Mother's birthplace, Germany.
12.—Place of residence, Oxford, Pa.
13.—Number of families in house,
14.—On what floor.
15.—Place of inquest, Third sub-Precinct.

F. KELLER, M. D.,
[L. S.] *Coroner.*

Place of burial, Lutheran Cemetery.
Date of burial, October 10, 1882.
Undertaker, T. J. Dougherty.
Place of business, 394 Hicks street.

CASE 16.

Testimony taken at the inquest held on the body of William Hueske, on the 10th of October, 1882, at the Third sub-Precinct Station House.

Bertha Hueske, sworn, and says: I am the sister of one of the men who died at the Annex Hotel, 14 Fulton street, on October 9, 1882, and whose body is now lying here; his name is William Hueske, he is twenty-six years of age, born in Germany, and has been in this country six months, in Oxford, Pennsylvania; he came to see me at the Annex Hotel where I am employed as chambermaid. Saturday night he slept in New York with his companion Theo. Hartke, who is also now dead; Sunday afternoon we three went out. Came back home, about 12.30 o'clock Monday morning; the two deceased were there; went to their room on the top floor of the Annex Hotel, room 29, and retired about 1 o'clock; at 7 o'clock, I went up stairs

and knocked at their room door, but received no answer, and thought I would let them sleep longer; at about 10 o'clock, Mr. Jugerversen, another boarder, called to me that he had smelled gas coming from room 29, that being the room where my brother and deceased Hartke were, I rushed up stairs, opened the window leading from the hallway into the room, I then crawled through the window and found a strong odor of gas in the room; I unlocked the door leading into the hallway, my brother was dead, lying in bed, as was also Theo. Hartke.

[Signed], BERTHA HUESKE.

Eliza Grotz, sworn, says: I am employed at the Annex Hotel as a chambermaid. Yesterday morning at about 10 o'clock I heard Mr. Jugerversen, a boarder, say that the odor of gas was coming from room 29, on the top floor; I went upstairs, Bertha Hueske followed. She went in the room through the window and unlocked the door on the inside; there was a strong odor of gas in the room; I went to the gas jet and found it was fully turned on but was not burning, and the gas escaped; William Hueske and Theo. Hartke were lying dead in bed, and I turned off the gas.

[Signed], ELIZA GROTZ.

Rasmus Jugerversen, sworn, says: I live at the Annex Hotel and occupy room 28. I left my room at about 10 o'clock yesterday morning, I smelled the odor of gas coming from room 29 and notified the chambermaids.

[Signed], R. JUGERVERSEN.

William Meyer, sworn, says: I am one of the proprietors of the Annex Hotel; the two men came home Monday morning at half past 12 o'clock; they registered and were taken upstairs; they were sober; I heard no more of them until about half past 10 o'clock yesterday morning by the servants hollering; I went upstairs, found the door of room 29 open and the two occupants lying dead in bed, there was a strong odor of gas in the room.

[Signed], WILLIAM MEYER.

CORONER'S CERTIFICATE OF DEATH. (12,805.)

This is to certify that I, Ferd. Keller, M. D., Coroner in and for the county of Kings, have this, the 10th day of October, 1882, viewed the body of Wm. Hueske, who died at 14 Fulton street, in the First Ward of the city of Brooklyn; that I have held an inquest upon the said body, and that the verdict of the jurors is, that he came to his death by suffocation from illuminating gas, having blown out the gas instead of turning it off, on the 9th day of October, 1882.

1.—Full name, Wm. Hueske.
2.—Age, twenty-six years.
3.—Sex, male.
4.—White.
5.—Single.
6.—Birthplace, Germany.
7.—Occupation, laborer.
8.—If of foreign birth, how long in the U. S., six months.
9.—How long resident in city, six months.
10.—Father's birthplace, Germany.
11.—Mother's birthplace, Germany.
12.—Place of residence, Oxford, Pennsylvania.
13.—Number of families in house.
14.—On what floor.
15.—Place of inquest, Third sub-Precinct.

F. KELLER, M. D.,
[L. S.] *Coroner.*

Place of burial, Lutheran Cemetery.
Date of burial, October 10, 1882.
Undertaker, F. J. Dougherty.
Place of business, 394 Hicks street.

CASE 17.

Testimony in the case of Susan E. Fendick, taken at 111 Fort Green Place, October 29, 1882.

Emma K. Jeffrey sworn, says: I live in the house, and the deceased is my stepsister; her name is Susan E. Fenwick, she is nineteen years and seven months old. She slept on the third floor front, hall room, alone. She left to retire at about twelve o'clock on Friday evening last; on Saturday, yesterday morning, at about 7.15 o'clock I went upstairs for the purpose of waking deceased, as was my custom every day, a chair was placed against the door on the inside. I at first knocked and called deceased, but received no answer; I opened the door a little at first, and then smelled a strong smell or odor of gas in the room; as I went to open the window I found the key of gas chandelier turned on fully; if the key was turned to the right, it caught and turned off the gas, but if turned toward the left it would not catch and allow the gas to escape, and in this condition I found the gas turned on. I opened the window, and then I saw that deceased was dead; the body was still warm. I came down stairs and told my mother; then doctors were sent for; they responded, but on their arrival declared her to be

dead, though they used means to revive her. Deceased was very tired when she went to bed. She was of a cheerful disposition.

[Signed], EMMA K. JEFFREY.

Leonard J. Huking, Jr., sworn, says: I reside at 111 Fort Green place; I am a brother-in-law of the deceased. The first I heard of this matter was when I heard the previous witness calling out that her stepsister, Susan, was dead. I entered the room where deceased was lying as soon as I was dressed partially, a physician was already present trying to resuscitate her, deceased, and delared she was dead.

[Signed], LEONARD J. HUKING, Jr.

Susan Jeffrey, sworn, says: I am the mother of the deceased, Susan E. Fendick; the gas chandelier in the room in which deceased slept was examined by Messrs. Robinson & Dean, plumbers, within this year; at the time of the examination they screwed it tight and pronounced it safe. The gas fixtures, to my knowledge, have been in the house since I have lived there, and I have often cautioned my daughter to be careful, as I knew that the key, if turned in one direction, would not catch and come to a stop, but would be over-turned.

[Signed], SUSAN JEFFREY.

My opinion as a physician, from the evidence and appearance of the body and manner of death is, that death resulted from suffocation.

F. KELLER,
Coroner.

Coroner's Certificate of Death. (13,433.)

This is to certify, that I, Ferdinand Keller, Coroner in and for the County of Kings, have this, the 29th day of October, 1882, viewed the body of Susan E. Fendick, who died at 111 Fort Green place, in the Eleventh Ward of the city of Brooklyn; that I have held an inquest upon the said body, and that the verdict of the jurors is, that she came to her death by suffocation from illuminating gas which escaped by being improperly turned off, on the 28th day of October, 1882.

1.—Full name, Susan E. Fendick.
2.—Age, nineteen years, seven months.
3.—Sex, female.
4.—White.
5.—Single.

6.—Birthplace, Brooklyn.
7.—Occupation—
8.—If of foreigh birth, how long in the United states—
9.—How long resident in city, life.
10.—Father's birthplace, England.
11.—Mother's birthplace, England.
12.—Place of residence, No. 111 Fort Green place, Brooklyn, Eleventh Ward.
13.—Number of families in house, one.
14.—On what floor—
15.—Place of inquest, 111 Fort Green place.

F. KELLER, M. D.,
[L. S.] *Coroner.*

Place of burial, Greenwood Cemetery.
Date of burial, October 31, 1882.
Undertaker, C. H. K. Smith. Place of business, 846 Fulton street.

CASE 18.

Inquest held on the body of Hannah C. Johnson at No. 215 Graham street, March 16, 1883.

Henry M. Dean, being duly sworn, says: I reside at 215 Graham street, Brooklyn; am a son-in-law of deceased. Deceased has been living in my family since last November. She was seventy-nine years of age; she retired about nine o'clock Wednesday night; my wife went to call deceased about 6.30 yesterday morning and knocked at the bedroom door of deceased, but receiving no answer, and becoming alarmed, called to me, and in company with my son I entered her room by way of the back window and found deceased lying upon her side in bed; she was unconscious; I sent for Dr. Quinn, of Kent avenue, who came, and after an examination of body of deceased pronounced life extinct; when I entered the room of deceased I was almost overpowered by the fumes of gas escaping, and I then discovered that the gas was escaping from a burner behind the bed; deceased did not use the gas burner in her room but used a kerosene lamp; she was in the habit of hanging a bundle of valuables on the gas bracket, and the only way I can account for the gas escaping is that in placing the bundle on the bracket she accidentally turned the cock and thus allowed the gas to escape. Deceased always bolted and locked her door; I found the gas cock open.

HENRY M. DEAN.

John R. Quinn, M. D., being sworn says: I reside at 423 Kent avenue, Brooklyn; am a practising physician; was called about seven o'clock yesterday morning to see deceased; I went there and found her lying in bed, and made an examination and found that she was pulseless; she had been dead about two or three hours. In my opinion the cause of death was asphyxia, due to the inhalation of gas; when I arrived at the house of deceased and went into the bedroom where she was lying, I noticed a slight smell of gas; the window was open.

JOHN RANDOLPH QUINN.

Sworn before me this 16th day of March, 1883.

F. KELLER, M. D.,
Coroner.

CORONER'S CERTIFICATE OF DEATH. (2,732.)

This is to certify that I, Ferdinand Keller, M. D., Coroner in and for the county of Kings, have this, the 16th day of March, 1883, viewed the body of Hannah C. Johnson who died at 215 Graham street, in the Seventh Ward of the city of Brooklyn; that I have held an inquest upon the said body, and that the verdict of the jurors is, that she came to her death by asphyxia, due to the inhalation of illuminating gas, on the 15th day of March, 1883.

1.—Full name, Hannah C. Johnson.
2.—Age, seventy-nine years.
3.—Sex, female.
4.—White.
5.—Widow.
6.—Birthplace, United States.
7.—Occupation—
8.—If of foreign birth, how long in the United States—
9.—How long resident in city, three months.
10.—Father's birthplace, United States.
11.—Mother's birthplace, United States.
12.—Place of residence, No. 215 Graham street, Brooklyn, Seventh Ward.
13.—Number of families in house, one.
14.—On what floor—
15.—Place of inquest, 215 Graham street.

F. KELLER, M. D.,
[L. S.] *Coroner.*

Place of burial, Nyack, Rockland County.
Date of burial, March 17, 1883.
Undertaker, L. Ruoff; place of business, 248 Devoe street.

CASES 19 and 20.

The history of these cases will be found with that of case 5.

CASE 21.

Copy of inquisition in the case of Geo. H. Hanf. Suffocation by gas, May 10, 1883.

Miss Nettie A. Hanf, being duly sworn, says:

I reside at 128 Rutledge street, Brooklyn; am a granddaughter of the deceased, who was seventy-seven years of age; deceased retired about 10 o'clock last Tuesday night in apparently good health. About half past 7 o'clock yesterday morning I had occasion to go up stairs, and in passing the room of deceased I noticed a strong smell of escaping gas. I opened the door of his room and found him lying in the bed. His body was partly out of the bed, and he was lying on the side of his face. He was unconscious. I called immediately for my parents, and they came up into the room. Dr. McLenathan was sent for and came, and after examination of body pronounced life extinct. I noticed that the gas cock was turned on full, from which the gas was escaping. The only way I can account for the gas cock being open is, that the deceased in turning it, turned it to the right instead of the left, thereby allowing the gas to escape.

NETTIE HANF.

Sworn, May 10, 1883.

R. KELLER, M. D.,

Coroner.

CORONER'S CERTIFICATE OF DEATH. (4,988.)

This is to certify that I, Ferd. Keller, M. D., Coroner in and for the County of Kings, have this, the 10th day of May, 1883, viewed the body of John A. Hanf, who died at 128 Rutledge street, in the Nineteenth Ward of the City of Brooklyn; that I have held an inquest upon the said body, and that the verdict of the jurors is, that he came to his death by asphyxia, by illuminating gas, on the 9th day of May, 1883.

1.—Full name, John A. Hanf.
2.—Age, seventy-seven years.
3.—Sex, male.
4.—White.
5.—Widower.
6.—Birthplace, Germany.
7.—Occupation, none.

8.—If of foreign birth, how long in the United States, forty-five years.

9.—How long resident in city, twenty-four years.

10.—Father's birthplace, Germany.

11.—Mother's birthplace, Germany.

12.—Place of residence, 128 Rutledge street, Nineteenth Ward, Brooklyn.

13.—Number of families in house, one.

14.—On what floor—

15.—Place of inquest, 128 Rutledge street.

F. KELLER, M. D.,

[L. S.] *Coroner.*

Place of burial, Greenwood.

Date of burial, May, 11, 1883.

Undertaker, Bryant; place of business, Fourth street.

CASE 22.

97 SECOND PLACE, May 27, 1883.

A few days ago I received a note from Dr. Wyckoff, stating that you were desirous of being made acquainted with the facts regarding a case of poisoning by gas (carburetted hydrogen), in which I acted as attending physician. Having lost my notes of the case I can only give you the essential facts as remembered.

I was called one morning at about 7 o'clock to visit a man named Creighton, a coachman by occupation.

On my arrival at the house I was informed by the servants that after repeated knocks at Creighton's door, without a response, and the odor of gas very strong, they became alarmed and broke down the door. Gas filled the room and was still escaping from a burner that was turned about half on. They found him partially undressed, stretched upon his bed, perfectly unconscious and breathing heavily. Unable to arouse him a physician was sent for. I found him in about the condition they described—unconscious, breathing stertorously, or rather in a manner resembling stertor; the cheeks puffing out with each expiratory effort, froth coming from the mouth but the snore absent; face blotched and livid, and while the respiration was very slow, there was a rapid action of the heart, with good volume to the pulse.

I ordered all of the doors and windows to be opened to their full extent, and had patient moved so that his head was on a level with an open window, and close beside it.

I then resorted to artificial respiration, after the manner advised by Sylvester, ordering the others present to apply friction to the extremities with hot mustard water. Inhalations of ammonia gas were given about every five minutes, and occasionally fifteen drop doses of the aromatic spirit of ammonia internally. I was compelled several times to cease and seize his tongue with a pair of forceps to permit a free passage of air.

Finding by the improved action of the heart and lungs that my efforts were meeting with success, I continued without resorting to any other means.

After working hard for about an hour and a half I had the satisfaction of finding my patient able, with a little support, to sit up in bed and mumble a few words of disapproval at the treatment he was undergoing. From this period his improvement was rapid, and by the following morning the effect of the gas had entirely disappeared.

The supposition is that he returned home, and that in turning off the gas, which he had left burning before going out, he partially re-turned it on.

Should you desire any further information regarding any particular point, I will cheerfully give it, if possible.

Trusting that you will pardon my delay in writing, I am,

Most respectfully,

JOHN C. McEVITT.

CASE 23.

Copy of testimony taken at an inquisition held January 27, 1882, on the body of Thomas Wallace, at 85 Myrtle Avenue :

Alexander Lees, examined, deposes and says: I am a police officer, stationed at the First precinct. January 24, 1882, at 7 o'clock I was sent by the sergeant at the desk to 362 Pearl street. I went there, went up stairs on the top floor, where I smelled a deadly odor, somewhat like gas and somewhat like that emanating from a dead body; I was informed that in the front hall room there was a man and his wife, Thomas Wallace, and Susannah M. Wallace, his wife, in bed, and that they could not be aroused. I knocked at the door of the room indicated several times, but received no response, and after obtaining permission I forced in the door; a very strong smell came from the room, like gas, so strong as to take away my breath and drive me back for a moment, but I immediately rushed in the room and opened the window; I heard a moan coming from the bed, and on looking back I saw Thomas Wallace and his wife

in bed; Mrs. Wallace was then dead, in my opinion; Thomas Wallace was still living; on the floor in the room I saw a gas stove, connected with the gas jet above by means of a rubber tube; whether I turned off the gas or not, or if the same was burning on my entrance in the room I do not recollect, as I was so excited and stupefied by the gas smell; the stove was warm, however—hot, so to say, and appeared as if it had recently been burning, and I believe I turned off the gas; I sent for the ambulance and for Dr. Briggs, and returned and assisted Dr. Briggs in taking the dead body of Mrs. Wallace in to another room; the doctor and I also made an examination of the stove and fixtures, and found no leaks anywhere.

[Signed], ALEXANDER LEES.

Benjamin M. Briggs, M. D., sworn, says: I am a practising physician and surgeon, residing at 106 Willoughby street. I was called to 362 Pearl street, January 24, 1882, at 7 o'clock A. M.; I found on the top floor, front hall room, Mrs. Wallace, dead; Thomas Wallace was lying in bed next to his wife, suffering from symptoms of suffocation from fumes of combustion of illuminating gas; in the room, on the floor, I found a gas stove, which upon examination appeared to be old and rusty; it was warm, as if it had been recently burning; I could not, on testing and examination, find any leak in the pipe, stove or fixtures, but in my opinion there was an incomplete combustion of the gas in the stove. I treated Thomas Wallace until his death, January 26, 1882, and in my opinion his death resulted from exhaustion, due to the result of suffocation and poisoning of fumes of illuminating gas.

BENJAMIN M. BRIGGS, M. D.

Coroner's Certificate of Death. (1,185.)

This is to certify, that I, Ferdinand Keller, M. D., Coroner in and for the County of Kings, have this, the 27th day of January, 1882, viewed the body of Thomas Wallace, who died at 362 Pearl street, in the Fourth Ward of the City of Brooklyn; that I have held an inquest upon the said body, and that the verdict of the jurors is that he came to his death by exhaustion, due to suffocation and poisoning from the inhalation of gas, caused by the incomplete combustion of gas from a gas stove burning in the room where deceased slept, on the 26th day of January, 1882. Time till death, two days.

1.—Full name, Thomas Wallace.
2.—Age, seventy-one years.

3.—Sex, male.
4.—White.
5.—Married.
6.—Birthplace, United States.
7.—Occupation, baker.
8.—If of foreign birth, how long in the United States—
9.—How long resident in city, 61 years.
10.—Father's birthplace, Scotland.
11.—Mother's birthplace, Scotland.
12.—Place of residence, No. 362 Pearl street, Brooklyn, Fourth Ward.
13.—Number of families in house, three.
14.—On what floor, third.
15.—Place of inquest, 85 Myrtle avenue.

F. KELLER, M. D.,

[L. S.] *Coroner.*

Place of burial, Evergreen Cemetery.
Date of burial, January 28, 1882.
Undertakers, S. Henderson & Son. Place of business, 62 Myrtle avenue.

CASE 24.

Susanna M. Wallace, 362 Pearl street. Alex. Lees: I am a police officer stationed at the First Precinct. Yesterday morning at 7 o'clock, I was sent here by the sergeant at the desk. I came here, I went upstairs on the top floor with John Cussick and Thomas McGann; knocked at Patrick Cussick's door; I smelled a deadly smell in the hallway; I was informed that in the front hall room there was a man and his wife in bed, and that they could not be aroused; I knocked several times at the door, but received no response, and after obtaining permission, I shoved in the door; I found a very strong smell somewhat like gas and like that of a corpse; the smell was strong as to take away my breath, and drove me back; I went in immediately, however, and opened the window; don't know whether I turned off the gas; I heard a moan in the bed, and found Thomas Wallace with his wife in bed, the woman I thought was dead; I went to summon an ambulance and sent for Dr. Briggs; on the floor of the room I saw this gas stove; I believe to the best of my knowledge the gas was burning in the stove; the stove was warm, and I do not recollect whether I turned off the gas or not, as I was excited, and as the gas kind of stupified me; after sending for the ambulance,

I came back and I assisted Dr. Briggs and Mr. Cussick, and we removed the body of Mrs. Wallace to the next room.

[Signed], ALEX. LEES.

Benjamin M. Briggs, sworn, says : I am a practising physician and surgeon, residing at 106 Willoughby street. I was called here about 7 o'clock yesterday morning by a police officer ; I found here on the top floor, in the front hall room, Mrs. Wallace dead, Thomas Wallace was asphyxiated, his wife being dead at his side, suffering from symptoms of suffocation from fumes of combustion of illuminating gas ; in the room on the floor I found this gas stove there ; I made an examination of the gas stove, found it to be an old one, which was warm and appeared as if it had been recently burning ; found no leaks in the pipe or fixtures ; from the symptoms of the sick man, the condition of the room, the smell existing therein, post-mortem appearances, &c., I am of the opinion that death resulted from suffocation due to the poisonous gas arising from incomplete combustion of the gas stove and want of ventilation.

[Signed], BENJAMIN M. BRIGGS.

January 25, 1882.

Coroner's Certificate of Death. (1,062.)

This is to certify that I, Ferdinand Keller, M. D., Coroner in and for the county of Kings, have this, the 25th day of January, 1882, viewed the body of Susanna M. Wallace, who died at 362 Pearl street, in the Fourth Ward of the city of Brooklyn ; that I have held an inquest upon the said body, and that the verdict of the jurors is, that she came to her death by suffocation due to the inhalation of poisonous gases arising from the incomplete combustion of gas in the gas stove burning in the room where deceased slept, on the 24th day of January, 1882.

1.—Full name, Susanna M. Wallace.
2.—Age, sixty-one years.
3.—Sex, female.
4.—White.
5.—Married.
6.—Birthplace, Canada.
7.—Occupation.
8.—If of foreign birth, how long in the United States, fifty-five years.
9.—How long a resident in city, one day.
10.—Father's birthplace, England.

11.—Mother's birthplace, England.

12.—Place of residence, No. 362 Pearl street, Brooklyn, Fourth Ward.

13.—Number of families in house, one.

14.—On what floor—

15.—Place of inquest, 362 Pearl street.

F. KELLER, M. D.,

[L. S.] *Coroner.*

Place of burial, River View Cemetery, Trenton, N. J.

Date of burial, January 25, 1882.

Undertakers, Henderson & Son. Place of business, 62 Myrtle avenue.

CASES 23 and 24.

JAMES H. ARMINGTON, President.

DEAR SIR :

I beg leave to report that the deaths of Susanna M. Wallace and Thomas Wallace, her husband, (both nearly seventy years of age), occupying a hall bed-room in house No. 362 Pearl street, was caused by the fumes arising from an old worn out gas cooking stove, which they used to warm their room. This stove was connected with the burner on the bracket by a small imperfect rubber tubing. On the night of January 25, 1882, it seems they fell asleep, leaving the gas burning, and suffocation ensued. Susanna M. Wallace was found dead in the morning. Thomas Wallace lived until the 27th. inst.

Respectfully submitted,

[Signed], JAMES E. WEBB.

BROOKLYN, April 6th, 1882.

CASE 30.

Testimony in the case of Mary Jane Norton, as to the cause of her death, shows that the said Mary Jane Norton came to her death by "asphyxia," from inhaling sulphurous and other gases arising from burning coal in a defective furnace, in the house No. 196 Raymond street, in the city of Brooklyn, on the night of the 27th of March, 1872.

April 1, 1872. JOSEPH B. JONES,

Coroner.

Coroner's Certificate of Death. (15,430.)

This is to certify, that I, J. B. Jones, Coroner in and for the County of Kings, have this, the first day of April, 1872, viewed the body of Mary Jane Norton, who died at 196 Raymond street, in the Eleventh Ward of the city of Brooklyn; that I have held an inquest upon the said body, and that the verdict of the jurors is, that she came to her death by asphyxia, from coal gas, on the 28th day of March, 1872.

1.—Full name, Mary Jane Norton.
2.—Age, fifty-nine years, six months.
3.—Sex, female.
4.—White.
5.—Single.
6.—Birthplace, State of New York.
7.—Occupation.
8.—If of foreign birth how long in the United States.
9.—How long resident in city, ten years.
10.—Father's birthplace, United States.
11.—Mother's birthplace, United States.
12.—Place of residence, No. 196 Raymond street, Brooklyn, Eleventh Ward.
13.—Number of families in house.
14.—On what floor.
15.—Place of inquest.

J. B. JONES.
[L. S.] *Coroner.*

Place of burial, Greenwood.
Date of burial.
Undertaker, G. S. Davis ; place of business, Fulton avenue.

Testimony Taken at Coroners' Inquests.

CASE 32.

Leonce Abat, fifty years, 10 Waverley Place, October 27, 1866. He was found dead in bed about ten o'clock A. M. The room was full of gas and gas cock partly open. He had arrived from Europe the day previous.

Verdict of Coroner's jury: Asphyxia from the inhalation of illuminating gas.

CASE 33.

Maria O'Connor, fifteen years, Eighty-third street, between Third and Fourth avenues, November 30, 1866. She retired

DEATHS DUE TO INHALATION OF GAS—NEW YORK CITY.

Case No.	Name.	Date of Accident.	Location.	Age.	Result.	Kind of Gas found by this Investigation.	Remarks.	Authority.
32	Leonce Abat	October 27, 1866	10 Waverly place	50 years	Fatal	Illuminating Coal Gas	Gas cock partly open	Coroner.
33	Maria O'Connor	November 30, 1866	Eighty-third street, between Third and Fourth avenues	15	..	"	Gas-pipe left open	..
34	John F. Gantz	December 16, 1867	Bloomingdale road and Inwood lane	59	..	"	Gas stove stop-cock open	..
35	David English	November 5, 1869	United States Hotel, Fulton and Water streets	47	..	"	Stop-cock left fully open	..
36	Frank Hewlen	May 26, 1870	104 Eighth avenue	4½	..	"	Defective gas fixture	..
37	John Laughlin	January 31, 1871	1497 Third avenue	27	..	"	Open gas pipe, no fixture	..
38	Bernard Laughlin	January 31, 1871	1497 Third avenue	3	..	"	"	..
39	Susan Sands	January 31, 1871	1497 Third avenue	25	..	"	"	..
40	Ann Laughlin	January 31, 1871	1497 Third avenue	30	..	"	"	..
41	Donald Stewart	March 29, 1871	Putnam House, Fourth avenue	40	..	"	Room full of gas	..
42	Mr. Newman	April 9, 1871	New England Hotel	25	..	"	Gas-cock left open	..
43	Jane A. Cronkite	May 19, 1871	111 West Twenty-sixth street	16	..	"	Room full of gas	..
44	Henry A. Gerhardt	February 28, 1872	22 First street	44	..	"	Gas turned on almost full	..
45	Sophia Healy	December 6, 1873	Eighty-sixth street, between First and Second avenues	55	..	"	Inhaling unconsumed gas	.
46	Alexander Miller	May 11, 1874	51 East Tenth street	50	..	"	Gas-cock left open	..
47	John Brown	November 7, 1878	31 Bowery, hotel	30	..	"	"	..
48	Lorenzo M. Locoma	November 16, 1878	21 East Fourth street, hotel	17	..	Illuminating Water Gas	"	..
49	Leroy T. Nichols	April 18, 1879	St. Cloud Hotel	36	..	"	" suicide	..
50	Sarah McGurk	January 21, 1880	53 West Twelfth street	20	..	Cannot ascertain	Nothing additional ascertained	..
51	Lewis Baker	May 20, 1880	French's Hotel	65	..	Illuminating Coal Gas	Gas turned on	..
52	John Donovan	May 1, 1880	115 West Twenty-second street	45	..	Cannot ascertain	"	..
53	Adam S. Lawson	June 3, 1880	713 Broadway, hotel	53	..	Illuminating Water Gas	Nothing additional ascertained	..
54	Jacob Elofsky	September 19, 1880	84 Chatham street, hotel	52	..	"	Gas-cock left open	..
55	Sopha Ingenito	October 31, 1880	79 Spring street, hotel	21	..	"	"	..
56	Bertha Blumerneis	November 4, 1880	233 Henry street	17	..	"	"	..
57	John Seebo	November 18, 1880	Summit Hotel, Bowery	19	..	"	Burner taken off, suicide	..
58	Thomas Coleman	December 3, 1880	Putnam House	44	..	"	Gas-cock left open	..
59	Samuel Sherwood	December 16, 1880	Earle's Hotel, Canal street	25	..	"	"	..
60	Albert A. Stillwell	December 24, 1880	North River Hotel	37	..	"	"	..
61	Thomas Nolan	January 1, 1881	10 First street	35	..	Cannot ascertain	Gas escaping into room	..
62	Reosler P. Reynolds	January 3, 1881	Vandyck House, Bowery	22	..	Illuminating Water Gas	Gas-cock left open	..
63	Michael Lynch	January 14, 1881	332 East Twenty-seventh street	31	..	"	Gas escaping from burner	..
64	Barbara Weis	February 12, 1881	955 Third avenue	19	..	"	Gas-cock left open	..
65	Henriette Braundorfer	February 12, 1881	955 Third avenue	16	..	"	"	..
66	Gustav Berthien	April 3, 1881	310 Broome street	30	..	"	"	..
67	Daniel Schmidt	April 10, 1881	395 Bowery, hotel	28	..	Illuminating Coal Gas	" suicide	..
68	Sophie Svenson	April 25, 1881	200 West Ffty-sixth street	28	..	"	Gas-cock partly open	..
69	J. V. Minnot	July 29, 1881	6 West Eleventh street	50	..	Illuminating Water Gas	Room full of gas, suicide	..
70	Louis Ottersen	August 6, 1881	318 Fourth avenue	13	..	"	Suicide	..
71	J. B. Osborne	August 6, 1881	Church, Fourteenth street and Second avenue	27	..	Illuminating Coal Gas	Gas stove disconnected from pipe	..
72	Abijah Green	October 20, 1881	300 West One hundred and Twenty-fifth street, hotel	75	..	Illuminating Water Gas	Gas-cock left open	..
73	Joseph Caille	November 8, 1881	405 Sixth avenue	40	..	Cannot ascertain	Room full of gas	..
74	James Reid	November 22, 1881	387 Fourth avenue, hotel	56	..	Illuminating Water Gas	Gas-cock left open	..
75	Wm. Zimmerman	December 14, 1881	Foot of West Forty-sixth street, Municipal Gas Works	30	..	"	At work on top of a gas holder	..
76	Michael Coyle	January 25, 1882	28 Bowery, Vandyck Hotel	48	..	"	Gas-cock turned on full	..
77	Thomas J. Durand	February 16, 1882	Occidental Hotel	54	..	"	"	..
78	John H. Stryker	March 1, 1882	48 Chatham street	38	..	"	"	..
79	Fred. W. Hoffman	March 2, 1882	North River Hotel	23	..	"	"	..
80	Ellen Ker	March 4, 1882	245 West Eleventh street	78	..	Illuminating Coal Gas	Gas-cock partly open	..
81	Philetus R. Covert	June 1, 1882	French's Hotel	51	..	Illuminating Water Gas	Room filled with gas	..
82	William Meekin	June 1, 1882	3 Morris street, hotel	24	..	"	Gas-cock partly open	..
83	Mary A. Meekin	June 1, 1882	3 Morris street, hotel	18	..	"	"	..
84	William Thomas	June 26, 1882	28 Bowery	55	..	"	Gas-cock left open	..
85	Catharine Hottenroth	August 22, 1882	395 Bowery, hotel	44	..	Illuminating Coal Gas	" suicide	..
86	Josephine Pasant	September 14, 1882	Sturtevant House, Broadway	31	..	Illuminating Water Gas	" "	..
87	Jane E. Walcott	October 1, 1882	14 West Twenty-eighth street, hotel	16	..	"	"	..
88	Emma Strause	October 7, 1882	90 Cortlandt street, hotel	20	..	"	Room full of gas	..
89	Timothy Kelly	October 27, 1882	2299 Fourth avenue	45	..	"	Gas-cock left open	..
90	Mary Rowan	October 31, 1882	240 East Eighty-sixth street	20	..	"	No cause stated other than gas	..
91	Daniel Leamy	November 9, 1882	48 Chatham street, hotel	52	..	"	Gas-cock left open	..
92	Margaret C. Concannon	November 13, 1882	Astor Place Hotel, Third avenue	22	..	"	"	..
93	Hugh Concannon	November 13, 1882	Astor Place Hotel, Third avenue	23	..	"	"	..
94	Honorah Mahoney	December 15, 1882	4 Attorney street	17	..	"	"	..
95	Andrew L. Culver	January 8, 1883	90 Courtland street, hotel	58	..	"	"	..
96	Arthur Schofield	January 19, 1883	34 West Eleventh street	83	..	"	"	..
97	Frank M. Tornowska	January 27, 1883	30 Bowery	28	..	"	"	..
98	William Lawrence	March 1, 1883	Putnam House	59	..	"	Gas-cock partly open	..
99	William Mulcahey	March 17, 1883	48 Chatham street, hotel	39	..	"	Gas escaping into the room	..
100	Elizabeth W. Nauschwitz	May 29, 1883	Summit Hotel, Bowery and Canal street	40	..	"	Suicide	..
101	Mary Rhode	April 13, 1868	112 Cedar street	37	..	Coal Gas from stove	Damper of stove closed	..
102	Jenny Schroeder	January 6, 1879	331 East Fifteenth street	6	..	"	"	..

RECAPITULATION FOR NEW YORK CITY.

Illuminating Coal Gas	21
Illuminating Water Gas	44
Stove Coal Gas	2
Kind of Gas unascertained	4
Total	71

deaths 22 in 21

" 43 " 5

about 10 P. M.; the next morning a strong smell of gas was in her room and she was found dead in bed. Her employer testified that the gas was put in the house the day before, and the pipe in her room left open.

Verdict: Suffocation, caused by the accidental inhalation of coal gas. Harlem Gaslight Company.

CASE 34.

John F. Gantz, fifty-nine years, Bloomingdale road and Inwood lane, December 16, 1867. Deceased was a policeman; and was on a visit to his son; he retired between ten and eleven o'clock; about nine the next morning was found dead in bed, his face partly buried in the clothes; the room contained a gas stove; the stop cock leading to the stove was found open and the room full of gas.

Verdict: Suffocation from the inhalation of illuminating gas.

CASE 35.

David English, forty-seven years, United States Hotel, Water street, November 5, 1869. The proprietor testified that the deceased retired about 11.30 o'clock on the night of November 1, and was found in an insensible condition about 2 P. M., November 2. The room was full of gas—the stop cock turned fully on. He was attended by Dr. Ewen, and remained unconscious until he died 2 o'clock A. M., November 5. No other testimony.

Verdict: Poisonous inhalation of gas, deceased having accidentally left the gas in his room turned on during the night.

CASE 36.

Frank Hewlen, four and a half years, 104 Eighth avenue, May 26, 1870. He had the croup on Monday and was still ill. Thursday morning he was left in bed in a closed room, where there was a defective gas fixture. In the afternoon he was found unconscious, and died about 12 o'clock that night.

Verdict: Poisonous inhalation of gas.

CASES 37, 38, 39, 40.

John Laughlin, twenty-seven years; Bernard Laughlin, three years; Susan Sands, twenty-five years; Ann Laughlin, thirty years. 1497 Third avenue, January 31, 1871.

These persons occupied the second story back rooms, in which there was no gas fixtures—a gas pipe terminated in the ceiling. The gas was shut off. On Saturday a chandelier was put in the front room, which was used that evening. The service pipe was

found frozen and was thawed out. The next afternoon all four were found dead, the gas pouring out of the pipe in the ceiling.

Verdict: Asphyxia, from the inhalation of coal gas.

CASE 41.

Donald Stewart, forty years, Putnam House, March 29, 1871. He occupied room 40, Tuesday night, and was found at half past 9 the next morning lying on the bed unconscious, breathing heavily. Room full of gas. Dr. Thompson attended him, and he died at 4.30 o'clock, Thursday morning. No testimony from Dr. Thompson.

Verdict: Inhalation of illuminating gas.

CASE 42.

Mr. Newman, tweny-five years, New England Hotel, April 6, 1871. He retired between 8 and 9 o'clock Saturday night, intoxicated, and was foünd dead in bed about 5 P. M. on Sunday. The faucet was turned on, and the room full of gas.

Verdict: Poisoning, by inhaling illuminating gas.

CASE 43.

Jane Ann Cronkite, sixteen years, 111 W. Twenty-sixth street, May 19, 1871. A servant girl who occupied an attic room with only one window, and was found unconscious about 9 A. M. the next day, and died the following morning at 6 o'clock. The room was full of gas.

Verdict: Asphyxia, from inhaling coal gas.

CASE 44.

Henry A. Gerhardt, forty-four years, 22 First street, February 28, 1872. Deceased was heard in his room during the evening, and was found dead in bed about 11 o'clock the next forenoon. The gas was turned on almost full.

Verdict: Asphyxia, from the inhalation of illuminating gas.

CASE 45.

Sophia Healy, fifty-five years, Eighty-sixth street, between First and Second avenues, December 6, 1873. Deceased was a member of the Sisters of the Holy Communion; she retired about half-past nine, and was found the next morning lying in bed in a natural position, body quite warm. Dr. Blything and two other physicians were called, but there is no evidence given by them. The following testimony by one of the Sisters: There was a gas stove in the room, which was burning as it is usually burned, and the gas at the burner was partially turned

on and lighted. Dr. Wooster Beach made a post mortem examination, and said that death was caused by the inhalation of the illuminating gas that had escaped combustion and poisoned the air of the room.

Verdict: Inhalation of illuminating gas.

CASE 46.

Alexander Miller, fifty years, 51 East Tenth street, May 11, 1874. He was found dead in bed, face downwards, about 11 A. M., by a carpenter who went there to work. Bedroom full of gas, window and door closed; gas turned on but not lighted.

Verdict: Asphyxia, from inhalation of gas.

CASE 47.

John Brown, thirty years, 31 Bowery (hotel), November 7, 1878. Deceased and a woman named Lizzie Williams occupied room 4, night of November 6. About 5 P. M. next day they were both found unconscious; the gas freely escaping from the burner. They were removed to Chambers street Hospital. December 17, Lizzie Williams testified that they drank several glasses of beer, and that deceased was "pretty full." She said she fixed the gas to burn small, and that was the last she knew. Dr. Kudrick said deceased was brought to the hospital about 5.30 and died at 6.30 P. M., November 7, from congestion of lungs.

Verdict: Asphyxia, due to the inhalation of coal gas.

CASE 48.

Lorenzo M. Lacerna, seventeen years, 21 E. Fourth street (Hotel Espanol), November 16, 1878. He retired about 10.30 P. M., and was found dead in bed about 11 o'clock the next forenoon, the gas turned on and the room full of it; he arrived from Europe the day before.

Verdict: Asphyxia, from suffocation by gas.

CASE 49.

Leroy T. Nichols, 36 years, St. Cloud Hotel, April 18, 1879. Deceased retired about 11.30 P. M., to room 120 on top floor. About 7.30 the next morning the gas was found turned on, not burning; window closed tightly. He was found lying on the bed, dressed, with his face embedded in the pillows.

Suicide, by the inhalation of illuminating gas.

CASE 50.

Sarah McGurk, twenty years, 53 West Twelfth street, January 21, 1880. A servant girl who was found in her room un-

conscious; was removed to New York Hospital about 4 P. M. The next morning œdema of lungs developed and she died about 10 o'clock P. M. She had been in the country only a few weeks.

Verdict: Asphyxia, from accidental inhalation of illuminating gas.

CASE 51.

Lewis Baker, sixty-five years, French's Hotel, May 20, 1880. Occupied room 76; the next morning was found lying on the floor dead; gas turned on.

Verdict: Asphyxia due to the inhalation of illuminating gas.

CASE 52.

John Donovan, forty-five years, 115 West Twenty-second street, May 1, 1882. He retired about 11 P. M., April 29. Next morning between 8 and 9 o'clock was found breathing heavily and could not be aroused. Gas was turned on and escaping.

Verdict: Pulmonary apoplexy and œdema of lungs, caused by partial suffocation with illuminating gas.

Wm. Stratford, M. D., testified that he was called to see John Donovan about 9.30 A. M., April 30; that on entering the room in which he lay a distinct odor of illuminating gas was perceptible, although the door and window was then open; that he found the surface of the body pale; the extremities cold; the ocular conjunction injected; diameter of pupil normal; mucous membrane exposed to view, pale; great dyspnœa; pulsation absent in the radial; pauses in the respiration; heart's action faint, and more frequent than normal (92-104); slight attempt at vomiting; coma; anæsthesia of cutaneous surface; paralysis of voluntary muscles; percussion gave dullness on right side; that later in the day on examining the blood he found it wore a bright cherry red color; and the spectroscope showed the oxyhaen and globien bands near the violet end of the spectrum normal; urine secreted by kidneys of sp. gr. of 1027, non-albuminurious; and that he believes the cause of these symptoms to be the inhalation of illuminating gas.

P. E. Donlin, M. D., being sworn, says: I made an autopsy on the body of the deceased and found heart flabby—otherwise normal. Lungs, left one œdematous, slightly congestive; right, pulmonary apoplexy; mucous membrane of bronchial tubes inflamed; fatty degeneration of liver; congestion of kidneys; mucous congestion of stomach; brain normal.

CASE 53.

Adam S. Lawson, fifty-three years, 713 Broadway (New Southern), June 3, 1880. Went to bed on top floor intoxicated. About half past five next morning was found lying on the floor and died soon after.

Verdict: Asphyxia from accidental inhalation of illuminating gas.

CASE 54.

Jacob Elofsky, fifty-two years, 84 Chatham street, Crook's Hotel, September 19, 1880. He occupied room 51, Friday night, September 17. Three times the next day the chambermaid tried to get into the room ; the clerk told her to let him sleep ; about 4 P. M. Sunday, 19th, she tried to look through the fanlight, she noticed then a smell of gas ; Mr. Crook burst open the door and found deceased lying dead in bed ; gas turned on full force, windows closed, and room full of gas.

Verdict: Accidental suffocation by illuminating gas, about September 19. New York Gas Company.

CASE 55.

Sophia Ingenito, twenty-one years, Anson House, 79 Spring street, October 31, 1880. She arrived from Europe October 30, and occupied room 16 the same night ; next morning was found dead on the floor ; gas turned half on and room full of gas ; did not understand the use of gas.

Verdict : Asphyxia from accidental inhalation of illuminating gas.

CASE 56.

Bertha Blumerneis, seventeen years, 233 Henry street, November 4, 1880. Deceased had been in the country only a few days. She was found dead in bed on the morning of November 4.

Verdict: Asphyxia due to the inhalation of illuminating gas, by leaving the gas turned on in her room.

CASE 57.

John Seebo, 19 years, Summit Hotel, Bowery, November 18, 1880. He went to his room about 9 P. M., and was found dead in bed about 2 P. M. next day. The gas was turned on and the burner taken off ; stove pipe hole was found stuffed with rags.

Verdict: Suicide by asphyxia, from the inhalation of illuminating gas.

CASE 58.

Thomas Coleman, forty-four years, Putnam House, December 3, 1880. Deceased occupied room 129, night of December 2. About 3.30 A. M. the watchman discovered gas coming from said room. Forcing the door open he was found dead in bed, and the gas turned full on.

Verdict: Asphyxia, from the inhalation of illuminating gas.

CASE 59.

Samuel Sherwood, twenty-five years, Earle's Hotel, Canal street, December 16, 1880. Occupied a room, December 13. Next day was found unconscious and taken to St. Vincent's Hospital, where he died December 16, at 4 A. M. The gas was found turned on in full force in his room.

Verdict: Congestion of lungs, due to partial suffocation by illuminating gas.

CASE 60.

Albert A. Stillwell, thirty-seven years, North River Hotel, 109 Barclay street, December 24, 1880. Deceased went to his room about 3 A. M., December 24, and was found dead about 7 P. M. same day. Room full of gas—the stop cock being turned about two-thirds on. Fanlight and window closed.

Verdict: Inhalation illuminating gas.

CASE 61.

Thomas Nolan, thirty-five years, 10 First street, January 1, 1881. About 11 A. M., January 1, the deceased and a woman were found in bed, with the gas freely escaping into the room. The man was dead; the woman unconscious. On February 14 the woman testified that she went to Nolan's room on New Year's eve, and that they were both drunk. They went to bed, and she remembered nothing more until she awoke in the hospital.

Verdict: Inhalation of illuminating gas.

CASE 62.

Rensler P. Reynolds, twenty-two years, Vandyke House, 28 Bowery, January 3, 1881. A sailor who registered his name January 2, and was found dead about 11 o'clock next day. Room full of gas and turned fully on.

Verdict: Asphyxia, due to the inhalation of illuminating gas.

CASE 63.

Michael Lynch, 31 years, 332 E. Twenty-seventh street, January 14, 1881. He was found in his room about 11 A. M.,

January 13, unconscious; room full of gas and escaping from the burner; he was taken to Bellevue Hospital and died at 3 o'clock next morning.

Verdict: Asphyxia, from œdema of lungs, caused by accidental suffocation by illuminating gas.

Geo. M. Swift, M. D., of Bellevue Hospital, testified that deceased was brought to the hospital about 1 P. M., January 13, insensible; pupils dilated, but responded to light; complete loss of reflex actions; there was an odor of gas about the man; later, there were convulsive movements of jaws; patient never recovered consciousness. By 5 P. M. was weaker, and had pulmonary œdema well marked by 7 P. M. Died about 3 A. M. of January 14.

CASES 64 and 65.

Barbara Weis, nineteen years, 955 Third avenue, February 12, 1881. Henriette Braundorfer, sixteen years, 955 Third avenue, February 12, 1881.

They occupied a hall bedroom and retired about 11 o'clock. They were found dead in bed about 7 the next morning; gas was turned on and escaping into the room.

Verdict: Asphyxia, by accidental suffocation from illuminating gas.

CASE 66.

Gustave Bertlein, 30 years, 310 Broome street, April 3, 1881. Deceased was found unconscious in his room, the gas burner open. Dr. Neuman administered restoratives; two days afterward he was sent to Chambers Street Hospital. The house surgeon testified that at 12.25, April 2, the deceased was brought there in an unconscious condition, suffering from coal gas poisoning, and that he died at 8 A. M., April 3. An autopsy revealed chronic meningitis and acute pericarditis.

Verdict: Asphyxia, from illuminating gas.

CASE 67.

Daniel Schmitt, twenty-eight years, 395 Bowery (hotel), April 10, 1881. He was found dead in bed, the gas turned on full and windows tightly closed; no time given.

Verdict: Suicide by the inhalation of illuminating gas.

CASE 68.

Sophie Svenson, twenty-eight years, 200 West Fifty-sixth street, April 25, 1881. A servant girl, found dead on the bed, undressed; gas half turned on; no particulars.

Verdict: Asphyxia, due to the inhalation of illuminating gas.

CASE 69.

J. V. Monnot, fifty years, 6 West Eleventh street, July 29, 1881. Found lying on the bed dead, room full of gas; his wrist had been cut and a pool of blood was on the floor.

Verdict: Exhaustion from hemorrhage and asphyxia from illuminating gas. A suicide.

CASE 70.

Louis Ottersen, forty-three years, 318 Fourth avenue, August 6, 1881. A suicide; found dead in an ice box; box full of gas and air holes all stopped up; the gas was conveyed to the box by a rubber pipe.

Verdict: Asphyxia from inhaling illuminating gas.

CASE 71.

J. B. Osborne, twenty-seven years, Fourteenth street and Second avenue, August 6, 1881. He was sexton to Fourteenth Street Presbyterian Church; on Sunday noon he was found dead in the library room; a gas stove had become disconnected from the gas pipe, which allowed the gas to escape; supposed to have been dead two or three days.

Verdict: Asphyxia, due to inhaling illuminating gas.

CASE 72.

Abijah Green, seventy-five years, 300 West 125th street, October 20, 1881. A Presbyterian clergyman from Highland Falls; he retired about ten P. M., and was found dead in his room about eight o'clock the next morning, gas turned on full force.

Verdict: Accidental suffocation due to inhaling illuminating gas.

CASE 73.

Joseph Caille, forty years, 405 Sixth avenue, November 8, 1881. A strong smell of gas was noticed coming from the room occupied by the deceased; on entering it he was found unconscious, and he died on the following morning; a physician was in attendance but there is no testimony from him.

Verdict: Œdema and congestion of the lungs from inhaling illuminating gas.

CASE 74.

James Reid, fifty-six years, 387 Fourth avenue, November 22, 1881. Deceased was found in his room at the Mills House on the morning of November 21, in an unconscious state and breath-

ing heavily; room was full of gas and gas key turned fully on; the window and fanlight tightly closed. Dr. Henry Blodget, house physician at Bellevue Hospital, testified that deceased was brought to the hospital during the afternoon of November 21, in a state of coma from having inhaled illuminating gas, and in spite of all remedies he died of heart failure at 2.30 A. M., November 22.

Verdict: By the inhalation of illuminating gas.

CASE 75.

William Zimmerman, thirty years, foot West Forty-sixth street, December 14, 1881. Deceased was a laborer at the Municipal Gas Company's works. On December 13, between 1 and 2 P. M., he was sent up on top of the tank to take off the manhole plate to let some of the gas escape, as the tank was too full; he was familiar with this work; the plate is oval and is on top of the gas holder, it is two and a half feet one way and five or six inches longer the other. After removing a few screws the force of gas lifts the plate up, and the gas escapes. He returned in about ten minutes; about 2.50 P. M. he was sent up again to close it. The continual settling of the holder without any known cause attracted attention; in seeking for the cause the manhole plate was discovered open, and deceased was found by the night foreman insensible with his feet pointing towards the manhole; the holder was sixty feet high at that time; about 7 P. M. he was lowered down and taken to the office and a physican sent for, afterwards he was removed to the hospital; no testimony from the night foreman. Dr. J. B. McMahon, house physician of Roosevelt Hospital, testified that deceased was brought to the hospital about 11 P. M., December 13, in a state of coma, which gradually deepened till death, which occurred at 8 A. M., December 14. He further testified that the autopsy revealed marked congestion of brain, kidneys, spleen, lungs and liver; right cavities of heart filled with red clots; left ventricle contracted and empty.

Verdict of jury: Asphyxia, from congestion of the lungs, from the inhaling illuminating gas, and we censure the company for not employing two men to do the work of letting off gas, the one to guard the other.

CASE 76.

Michael Coyle, forty-eight years, 28 Bowery, January 25, 1882. Deceased was found about 10 A. M., January 24, at the

Vandyke House, lying across the bed, unconscious; room full of gas and turned on in full. He was removed to St. Vincent's Hospital. Dr. S. Allen, house physician, says he was brought there about 1.30 P. M., and died about 8.30 P. M., January 25.

Verdict: Congestion of lungs, due to inhalation of illuminating gas.

CASE 77.

Thomas J. Durand, fifty-four years, Occidental Hotel, corner Bowery and Broome street, February 16, 1882. Retired about 10 P. M. under the influence of liquor and was found dead in bed about 7 o'clock the next morning. Gas turned on and room full of gas.

Verdict; Asphyxia, due to inhaling illuminating gas.

CASE 78.

Johnson H. Stryker, thirty-eight years, 48 Chatham street, March 1, 1882. Occupied a room in Brooklyn Bridge Hotel, February 28; between 10 and 11 o'clock next forenoon was found dead; gas turned on and escaping into the room.

Verdict: Asphyxia, due to inhaling illuminating gas.

CASE 79.

Fred. W. Hoffman, twenty-three years, North River Hotel, 109 Barclay street, March 2, 1882. Retired about 2 A. M. and was found dead between 12 and 1 o'clock the same day; gas turned on and room full of gas.

Verdict: Asphyxia, by illuminating gas, by accidentally leaving the gas open.

CASE 80.

Ellen Ker, seventy-eight years, 245 West Eleventh street, March 4, 1882. Occupied a hall bed-room; retired about 10.30 P. M.; was found dead early next morning lying on her back, frothing at the mouth; room filled with gas and turned about three-quarters on.

Verdict, accidental suffocation from inhaling illuminating gas.

CASE 81.

Philetus R. Covert, fifty-one years, French's Hotel, June 1, 1882. He retired about 11 P. M. and was found in a dying condition about 12 M. the next day. All efforts to resuscitate him failed, and he died about 1.15 P. M. Windows all fastened and room filled with gas.

Verdict: Asphyxia from illuminating gas.

CASES 82 and 83.

William Meekin, twenty-four years, 3 Morris street, June 1, 1882. Mary A. Meekin, eighteen years, 3 Morris street, June 2, 1882. Deceased man and wife went to the Eagle Hotel from Castle Garden about 9.30 P. M. After taking supper retired about 10.30 o'clock to a bedroom with one window. About noon next day they were found insensible from escaping gas, the key being turned about half way. Dr. Shine was called, and all efforts were made to restore them, but the man died, at 11 P. M. and his wife the next day. They had just arrived in the Batavia from England.

Verdict: Apnoea from œdema and congestion of lungs caused by asphyxiation by illuminating gas.

CASE 84.

William Thomas, fifty-five years, 28 Bowery, June 26, 1882. He was seen in his room at 9 P. M., and at 6 next morning was found dead; room full of gas; gas key turned on full and window closed.

Verdict: Suicide, by asphyxiation with illuminating gas.

CASE 85.

Catherine Hottenroth, forty-four years, 395 Bowery, August 22, 1882. Deceased left her home, 297 Bowery, and engaged a room at the Bowery Hotel (395.) About 10 A. M. the next day, August 20, she was found in an unconscious condition. Room full of gas, the key turned on full, and every crack stopped up with her clothes. She died at 295 Bowery, August 22. No doctor's testimony.

Verdict: Suicide, by illuminating gas while temporarily insane.

CASE 86.

Josephine Pasant, thirty-one years, Sturtevant House, Broadway, September 14, 1882. Deceased occupied a parlor bedroom, September 13, and was found dead in bed about 10 o'clock the next forenoon. The gas turned on full, windows and door tightly closed, and room full of gas.

Verdict: Suicide, by asphyxiation from inhalation of illuminating gas.

Dr. P. E. Donlin testified that he made an autopsy on the body, and found all organs normal except the stomach, which showed slight veinous congestion. Deceased was between two or three months pregnant.

CASE 87.

Jane Eliza Walcott, sixteen years, 14 West Twenty-eighth street, October 1, 1882. Deceased was on a visit from the country. Was found dead about 8 o'clock in the morning. Room full of gas, and the key turned fully on.

Verdict: Asphyxia, by accidental inhalation of illuminating gas.

CASE 88.

Emma Strauss, twenty years, 90 Cortlandt street, October 7, 1882. Deceased arrived from Germany, October 6, and took a room at Glen Island Hotel. About 7 o'clock the next morning was found dead in bed. Room full of gas.

Verdict: Asphyxia, from inhalation of illuminating gas.

CASE 89.

Timothy Kelly, forty-five years, 2,299 Fourth avenue, October 27, 1882. Deceased was found dead in his bed about 8 A. M. Gas turned on full and windows closed. Said to have been intoxicated the evening before.

Verdict: Accidental inhalation of illuminating gas.

CASE 90.

Mary Rowan, twenty years, 240 East Eighty-sixth street, October 31, 1882. Her employer being absent, deceased and her cousin, Margaret Ratsford, occupied the room together on the night of October 21. When Mr. Lyon returned home the next morning he noticed a strong smell of gas, and on investigation found both of them in bed insensible. He sent for two physicians. The next day deceased was sent to the hospital, and her cousin to relatives. Dr. H. A. Mandeville, house physician of Presbyterian Hospital, testified as follows:

Deceased was brought to the hospital October 23, at 10.51 A. M., in a semi-comatose condition. Respirations rapid, but full. No marked stertor. No œdema of lungs. Face presented a dusky appearance. Arms in flexed position and rigid. Muscles of both lower extremities in relaxed condition. Anæsthesia over whole body, with exception of abdomen, where pressure evidently caused pain. Condition of pupils not constant. She remained in this condition until the 26th, when her condition somewhat improved, and she answered a few questions; but on the 28th she relapsed into her former condition, the coma becoming more and more profound; temperature varied between 103 and 105½°; pulse rapid and weak. She remained in above condition, temperature gradually go g

respirations and pulse becoming more rapid and weak, until October 31, at 4.45 P. M., when she died. Autopsy held, revealing cause of death as follows: 1. Poisoning by illuminating gas. 2. Effusion into lateral ventricles of brain.

Verdict: Asphyxia, by inhaling illuminating gas.

CASE 91.

Daniel Leamy, fifty-two years, 48 Chatham street, November 9, 1882. Deceased retired about 11.30 P. M., to room 36, in N. Y. & B. B. Hotel, and was found dead in bed about 10 A. M. next day. The key was open and room full of gas.

Verdict: Asphyxia, from inhaling illuminating gas.

CASES 92 and 93.

Margaret C. Concannon, twenty-two years, 25 Third avenue, November 13, 1882. Hugh Concannon, twenty-three years, 25 Third avenue, November 13, 1882.

The deceased were recently married, and on the night of November 12th they occupied room 57 in Astor Place Hotel. They retired about 12 P. M., and about 7 the next morning their room was found full of gas, the gas cock turned fully on; Mrs. C. was dead; Mr. C. was barely breathing; he died soon after.

Verdict: Asphyxia, from accidental suffocation by illuminating gas.

CASE 94.

Honorah Mahoney, seventeen years, 4 Attorney street, December 15, 1882. Deceased was a domestic, and retired about 10 P. M., and was found dead in bed about 8 o'clock the next morning. The stop cock was turned full on, and the room full of gas.

Verdict: Asphyxia from accidentally inhaling illuminating gas.

CASE 95.

Andrew L. Culver, fifty-eight years, 92 Cortlandt street, January 8, 1883. Deceased left his home December 26, 1882, and did not return. His family made great efforts to find him, without success. On January 6 (Saturday), he went to the Glen Island Hotel, 92 Cortlandt street. His conduct was very strange—seemed worried. Was very irregular in going to bed. On Monday, between 12 and 1 P. M. he went to bed. About 10 A. M. the next day he was found dead in bed, the gas turned on, and room full of gas.

Verdict: Asphyxia, from illuminating gas (accidental.)

CASE 96.

Arthur Schofield, eighty-three years, 34 West Eleventh street, January 19, 1883. About nine o'clock in the evening the smell of gas was discovered coming from the room occupied by deceased; on entering the room the gas burner was found extinguished, but the tap was turned on and the gas escaping. Dr. F. Tilden Brown, one of the persons who first entered the room, testified as follows: On Thurday, January 18, I was called to St. Stephens Hotel, 34 West Eleventh street; on entering room I found body lying face downwards, dead, near door; I hastily lighted gas, and turning body over found all appearances of life extinct; with assistance of night watchman I tried to resuscitate him by artificial respiration, also gave stimulating injections hypodermically; continuing our exertions for about twenty-five minutes without any success, we concluded the man was dead; in my opinion the deceased died of asphyxia from illuminating gas.

Verdict: Accidental asphyxia from illuminating gas.

CASE 97.

Frank M. Tornowska, twenty-eight years, 30 Bowery, Jannary 27, 1883. The wife of deceased testified that her husband had been out of work for eleven weeks; he got work January 23d; he left home about six P. M., January 25th, drunk, without saying where he was going; about 12.30 P. M., the 26th, a servant in the New England Hotel heard groans in the room occupied by deceased, and notified the porter; deceased was found on the bed unconscious and was removed to another room; afterwards was removed to St. Vincent's Hospital; the gas cock was turned on and there was a strong smell of gas, but the gas was shut off at the metre. Dr. L. J. McNamara, house physician of St. Vincent, testified as follows: On January 26th, deceased was brought from 30 Bowery to this hospital by our ambulance, suffering from the effects of coal gas poisoning; he was unconscious and remained in that state until he died, about seven hours after entrance; his death was caused by asphyxia from the inhalation of coal gas.

Verdict: Asphyxia from accidental inhalation of illuminating gas.

CASE 98.

William S. Lawrence, fifty-nine years, Putnam House, March 1, 1883. About 8.15, March 1st, a smell of gas was noticed

coming from the room occupied by deceased; he was found lying on his left side apparently dead; they did everything to bring him to consciousness; the gas was found turned on about half way and the transom open about two inches.

Verdict: Asphyxia from illuminating gas accidentally inhaled.

CASE 99.

William Mulcahey, thirty-nine years, 48 Chatham street, March 17, 1883. About 1 o'clock A. M. deceased went to this hotel and was given a room; he requested to be called at seven A. M.; he was slightly under the influence of liquor; he was called at the hour named but he did not answer; about 4 or 5 P. M. an odor of gas was discovered coming from the room he occupied; the clerk entered with a latch key, and he was found dead and the gas escaping into the room.

Verdict: Asphyxia from illuminating gas. (Not suicidal.)

CASE 100.

This is to certify, that I, Bernard F. Martin, Coroner in and for the city and county of New York, have, this 29th day of May, 1883, viewed the body of Elizabeth Wagner Nauschwitz, aged about forty years, native of Germany, found at Summit Hotel, in the Tenth Ward of said city and county; that I have held an inquest upon the said body, and that the verdict of the jurors is, that she came to her death by asphyxia from illuminating gas.

Memorandum concerning the deceased.—Widow; color, white; occupation, nurse; how long in the United States, if of foreign birth, two years; how long resident in this city, two years; father's birthplace, Germany; mother's birthplace, Germany; place of death, Summit Hotel, corner Canal and Bowery; place of inquest, coroner's office.

BERNARD F. MARTIN,
Coroner.

I hereby certify, from examination and evidence, that said woman died on the 29th day of May, 1883, at — A. M., and that the cause of her death was suicide, by asphyxia from illuminating gas. Found in her room in Summit Hotel, corner of Canal and Bowery, May 29, 1883, at 2 A. M., by porter.

WM. F. JENKINS, M. D.,
Medical Attendant at Inquest.

Place of burial, Lutheran Cemetery; date, May 31; undertaker, John J. Ryan; place of business, 77 East Broadway.

CASE 101.

Mary Rohde, thirty-seven years, 112 Cedar street, April 13, 1868. Margaret Haskins occupied room with the deceased. They retired about half-past 11 o'clock, after putting some coal in the stove. About 4 the next morning a moaning sound was heard coming from the room which they occupied; they were found unconscious; physicians came very soon after and applied remedies for their restoration; Margaret testified that before falling asleep she felt sick at the stomach, and had a feeling of suffocation; afterwards became unconscious, and knew nothing more until she came to the next morning in the presence of two doctors. There is no statement from these physicians, nor any testimony in regard to the damper in the stove,

Verdict: Asphyxia, from the inhalation of coal gas.

CASE 102.

Jenny Schroeder, six years, 331 East Fifteenth street, January 6, 1879. Deceased and her sister Lizzie retired about 10.50 P. M., Sunday, January 5. About 8 o'clock the next morning she was found dead; Lizzie was unconscious and remained so until about 2 o'clock on Wednesday; she gave her testimony on the 15th. There was a stove in the room, which was filled with coal before retiring. The damper was found shut.

Verdict: Asphyxia, from the inhalation of coal gas.

Injury from Gas in Other Places in the United States.

In the course of this investigation I have endeavored to obtain information from other cities and towns. In some degree this has been successful. The following list gives the result. Other cases have been reported to me, but at so late a period that I have been unable to make any attempt at verification. They may, however, be found in the appendix.

CASES 103 and 123.

Health Department,
Office Superintendent of Health and City Register,
City Hall, Providence, May 16, 1883.

Your two letters of date, yesterday, are received. In case of E. L. Shattuck, died December, 1876; the gas referred to is illuminating gas, made from bituminous coal, which is the only kind of illuminating gas we have here. In truth, I do not know what you mean by water gas.

Death and Injuries from Inhalation of Gas in Cities and Towns of the United States, other than Brooklyn and New York.

Case No.	Name.	Date of Accident.	Location.	Age.	Result.	Kind of Gas Found by this Investigation.	Remarks.	Authority.
103	Enos L. Shattuck	December 24, 1876	Providence, R. I	23 years	Fatal	Illuminating Coal Gas	From gas stove	Superintendent of Health, Providence.
104	Mary Ellen Barry	December 19, 1877	Randolph, Mass	13 "	"	Stove Coal Gas	Parlor stove	Overseers of Poor, Randolph.
105	Catharine Ryan	December 19, 1877	Randolph, Mass		"	"	"	"
106	James Ryan	December 19, 1877	Randolph, Mass	13 years	"	"	"	"
107	John Ryan	December 19, 1877	Randolph, Mass	9 "	"	"	"	"
108	Johanna Ryan	December 19, 1877	Randolph, Mass	7 "	"	"	"	"
109	Dennis Ryan	December 19, 1877	Randolph, Mass	4 "	"	"	"	"
110	Mary McMasters	January 10, 1878	Boston, Mass		"	Illuminating Coal Gas	Stop-cock turned on full	Board of Health, Boston
111	Robert Young	January 20, 1878	Boston, Mass		"	"	"	"
112	August Bolle	November 17, 1878	Buffalo, N. Y		"	Stove Coal Gas	Defective furnace	City Clerk, Buffalo.
113	Gabriel Castro	November 20, 1878	San Francisco, Cal		"	Illuminating Coal Gas		Dr. A. W. Perry, San Francisco.
114	Frank M. Tucker	March 18, 1879	Providence, R. I	18 years	"	"	Turned off gas, no check	Coroner, Providence.
115	Benjamin Hanna	September 28, 1880	Stroudsburgh, Pa		"	Illuminating Gas	From kerosene oil	Coroner, Stroudsburgh.
116	Peter Dean	September 28, 1880	Stroudsburgh, Pa		"	"	"	"
117	J. Forester	October 1, 1880	Indianapolis, Ind		"	Illuminating Coal Gas	Blew out the gas	Board of Health, Indianapolis.
118	Mrs. J. Forester	October 1, 1880	Indianapolis, Ind		Not fatal	"	"	"
119	John Hopkins	May 7, 1881	Chicago, Ill		Fatal	"	Defective fixtures	Board of Health, Chicago.
120	Ten cases	1881	Erie, Pa		Not fatal	Coal Gas	Kind of gas not stated	Health Officer, Erie, Pa.
121	Lillie J. Brandt	May 5, 1882	Steamer Providence		"	Illuminating Coal Gas	Gas turned on, unlighted	Steamboat Company.
122	Emil Acoreie	May 5, 1882	Steamer Providence		"	"	"	"
123	James H. Langley	May 25, 1882	Steamer Bristol		Fatal	"	"	"
124	Annie Buck	October 12, 1882	Jersey City, N. J		"	"		Board of Health, Hudson Co.
125	W. Toland	November 18, 1882	Batavia, N. Y		Not fatal	"	Blew out the gas	Town Clerk, Batavia.
126	Willis Protter	November 22, 1882	San Francisco, Cal	15 years	Fatal	Illuminating Water Gas		Dr. A. W. Perry, San Francisco.
127	Mr. Soberanus	November 22, 1882	San Francisco, Cal	45 "	Not fatal	"		"
128	Isaac Battin	December 27, 1882	Philadelphia, Pa		Fatal	Illuminating Coal Gas	Turned off the gas and turned it on again	Board of Health, Philadelphia.
129	Frank Hahse	March 19, 1883	Boston, Mass		"	"	Suicide	Board of Health, Boston.
130	Nancy Braden	April 16, 1883	Oskaloosa, Iowa		"	Not ascertained	Turned off gas, no check	State Board of Health, Iowa.
131	Charles McCormick	April 10, 1883	Rochester, N. Y		Not fatal	Stove Coal Gas	Top of stove left open	Mayor of Rochester.
132	Mrs. Charles McCormick	April 10, 1883	Rochester, N. Y		"	"	"	"
133	Fifteen young ladies	October 16, 1880	Yonkers, N. Y		"			Can get no information.
134	W. H. Metcalf		Blackstone, Mass					No such persons known to the selectmen of Blackstone.
135	Son of W. H. Metcalf							
136	John Scrafford	March 18, 1879	Bath, Maine					No record on file with Superintendent of Burials, Bath, Me.
137	James McGrath		Scranton, Pa					Can get no information.
138	Miss Betz or Bedell		Scranton, Pa					"
139	Esther Burton		Albany, N. Y					No record at Board of Health, Albany.
140	F. Tilford		Philadelphia, Pa					No record at Board of Health, Philadelphia.
141	Wife of F. Tilford		Philadelphia, Pa					"
142	Artemus Ward	December 29, 1865	Worcester, Mass		Fatal	Anthracite Coal Gas	Whether illuminating or not, not stated	Board of Health, Worcester.
143	Wife of Artemus Ward	December 29, 1865	Worcester, Mass		"	"	"	"

RECAPITULATION, OTHER CITIES OF UNITED STATES.

Illuminating Coal Gas	15
Illuminating Water Gas	2
Stove Coal Gas	9
Gas made from Kerosene	2
Kind of Gas unascertained	13
Total	41

I know nothing about case of James H. Langley who died on "Newport Steamer." That is a Newport name, and I think your best chance for information would be to write to the City Clerk, Newport, R. I., who keeps the records of deaths there. Dr. Horatio R. Storer, of Newport, is much interested in sanitary matters and might be useful to you in your researches.

Truly yours,

E. M. SNOW.

CASES 104, 105, 106, 107, 108 and 109.

OFFICE OF BOARD OF
SELECTMEN, ASSESSORS AND OVERSEERS OF POOR,
RANDOLPH, MASS., May 14, 1883.

Your favor of April 17th is received and contents noted. Mary Ellen Barry, age thirteen; James Ryan, age thirteen; John Ryan, age nine; Johanna Ryan, age seven; Dennis Ryan, age four; died December 19, 1877, from suffocation caused by coal gas escaping from a parlor stove. Mrs. Catharine Ryan, mother, died December 22d from the same cause, she lingering three days after the decease of the children, but was never conscious after the 19th. As far as I can learn there was not any official investigation.

With respect, your obedient servant,

ROYAL T. MANN,

Chairman, Overseers of Poor, Randolph.

CASES 110 and 111.

COMMONWEALTH OF MASSACHUSETTS.
STATE BOARD OF HEALTH, LUNACY AND CHARITY,
DEPARTMENT OF HEALTH, STATE HOUSE,
BOSTON, May 9, 1883.

In reply to yours of 7th instant, Dr. Draper, the medical examiner in the cases reported, states that the fatal agent in both cases reported was coal gas.

Case 10, page 100, City Hospital reports; name of the deceased was Mary McMasters. Case 4, page 94; name of deceased was Robert Young.

Very truly yours,

S. W. ABBOTT,

Health Officer.

Case 10, City Hospital Reports, page 100, volume 3.

Asphyxia by illuminating gas. This woman, Mary McMasters, an ignorant servant girl from Nova Scotia, took a room in a

hotel on the evening of January 8, 1878, and retired early. Next day, at 1 P. M., the housekeeper noticed an odor of gas in the entry outside the lodgers' room; her door was forced and she was found in bed unconscious and moaning; her face was livid; her hand was over her mouth. The air of the room was saturated with gas and there was no ventilation; the stop cock of the gas fixture was turned on full; physicians were called who used stimulants, artificial respiration and other measures, but the patient did not regain consciousness; she died at 5 A. M., January 10th; there were no convulsions; the pupils were dilated and fixed.

External appearances, autopsy, nine hours post mortem: Cadaveric lividity fully developed, of a dusky purple color throughout dependent parts; slight *rigor mortis*; body cooled slowly, although the temperature of the atmosphere was below the freezing point when the body lay in the morgue; the eyes were bright, the pupils dilated; the facial expression was calm.

Internal appearance: The right cavities of the heart were distended with very dark fluid blood; the left ventricle was in systole and the small amount of blood contained in it held a few imperfectly formed clots; the blood in other parts of the body was of dark color and free from clots; the lungs were engorged, being of a uniform mulberry color on section and exhuding blood freely; the bronchial mucous membrane was reddened; the kidneys were injected; spleen normal; the intestines were pale and distended with flatus; the stomach and liver presented nothing noteworthy in their appearance; there was hyperæmia of the brain and its meninges.

Case 4, City Hospital Reports, page 95, volume 3.

Asphyxia in a burning building. Deceased, Robert Young, a man forty-five years old, occupied a room on the upper floor of a four-storied building. At 5 A. M., January 20, 1878, the building was found to be on fire in the second story; on inspection after the fire it was found that the damage was limited almost wholly to this second story; elsewhere there was an abundant deposit of sticky soot, with an odor of illuminating gas; all the tips had been removed from the gas fixtures on the second story and the stopcocks had been turned so that before the fire the gas had escaped in full force; the dead body of Young was found lying prone across the threshold of his room; the deposit of soot in the entryway and rooms of this fourth story was particularly noticeable.

External appearances: The body was partially clothed, and the portions of clothing in place had evidently been arranged hastily; all the exposed parts of the body, as well as the clothing, were thickly smutted with tenacious soot; no sign of burns about the body; there were patches of pink, cadaveric lividity on the anterior as well as the posterior parts of the body; the jaws were firmly apposed and the tongue was behind the teeth; there was no froth at the lips or nostrils; *rigor mortis* was unusually pronounced. The autopsy was made twenty-nine hours after the death, supposing the death to have occurred at the time of the discovery of the fire.

Internal appearances: The muscles were of a bright florid vermilion color; the heart was fully distended on its right side, empty and contracted on the left side; its color was bright red; the blood throughout the body was uniformly fluid in consistency and of a bright, lobster red color; the lungs were of a pinkish grey color externally, with many well marked sub-pleural ecchymosis; on section they appeared engorged, of a brilliant red color, with only moderate crepitation; the trachea, larynx and bronchi contained coarse mucous froth abundantly colored with soot; the mucous membrane of the air passage was injected; there was engorgement of the vessels of the peritoneum, kidneys, spleen, liver and stomach; the intestines presented various degrees of hyperæmia, from uniform pink staining to distinct sub-mucous extravasations; the vessels of the dura mater and of the vascular meninges were distended with bright red fluid blood, and the puncta cruenta on a cut section of the brain were abundant.

CASE 112.

City Clerk's Office,
Buffalo, N. Y., April 20, 1883.

Your circular (Form 81-B), of the 17th inst. is received and contents noted. With reference to the death of August Bolle, I find upon examination of record kept by the coroner, that August Bolle, Frenchman, was suffocated by coal gas at his room under the French church, at the corner of Washington and Clinton streets, November 17, 1878. The coroner certified to the death and cause of death; Dr. Slacer was called and approved certificate; no evidence was taken; the cause of death being apparent; the church having put in a new furnace, and coal gas escaping therefrom produced suffocation.

Yours,

Fee $1.00. W. P. BEERUS.

CASES 113, 126 and 127.

San Francisco, May 22, 1883.

Your father has sent me a note from you, requesting information in gas asphyxia cases. I will give you below the items of several. No autopsies are made in these cases, and the Coroner's inquests do not contain much useful information. The Board of Health has only a record of causes of death. The case you mention, G. Castro, November 20, 1878, was asphyxia by (coal) illuminating gas. No inquest or other legal inquiry was held.

On November 22, 1882, Willis Protter, fifteen years old, died from asphyxia at the Russ House in this city. The gas was turned on; it came from a jet on the opposite side of the room; under the jet Mr. Soberanus, aged forty-five, was lying; he was found comatose, but recovered after three days. The room has on the door a rule, "to take care to turn off the gas." The two had inhaled the gas about twelve hours. It is a water gas, enriched by coal gas and petroleum. The next cases took place May 21, 1883, the gas was the same as that last mentioned; the Coroner's *proces verbal*, does not in any of these cases contain as much information as I give you. I will continue as cases arise to send particulars. I would be obliged to you if you would send me, for use of the San Francisco Board of Health (of which I am a member), your rules dealing with contagious diseases, instructions to inspecting or disinfecting officers, circulars (if any) to house holder in isolating restriction of contagious diseases, the internal rules and diet tables of your City (charity Hospital.

Yours truly,

ALFRED W. PERRY, M. D.,

140 Stockton Street, San Francisco.

CASE 114.

Office, 17 College Street,
Providence, April 20, 1883.

Yours of 19th instant is at hand and contents noted; and in reply would say that Frank Wayland Tucker died in this city as stated in your letter. The circumstances of the case are these: Tucker was in the habit of reading after retiring, as he had done on the evening of March 17th; there was over his bed and about the center, a gas jet which is called a tea jet; Frank, after reading for some time, raised himself in bed and turned the gas off; as there was no stop to the cut-off it was turned about quater way past the proper place, allowing the gas to escape into

the room; he was found the next morning between 4 and 5 o'clock nearly dead; Dr. George H. Kenyon was called, but death ensued before his arrival; I was called as coroner, and after learning the above facts deemed an inquest unnecessary. The kind of gas was coal gas, such as the city is supplied with. The above facts are correct as near as I can remember; if you wish anything further, please write.

Respectfully yours,

C. H. THURBER,

Coroner.

PROVIDENCE, April 23, 1883.

Coal gas was what caused Tucker's death.

C. H. THURBER.

CASES 114 and 103.

HEALTH DEPARTMENT,
Office Superintendent of Health, City Hall,
PROVIDENCE, April 18, 1883

DEAR SIR:

Frank Wayland Tucker, age eighteen years, died in this city March 18, 1879. Cause of death: Asphyxia from illuminating gas (gas made from bituminous coal.) Charles H. Thurber was coroner; but there is little probability that any inquest was held.

Enos L. Shattuck, age twenty-three years. Died in this city December 24, 1876. Cause: Suffocation from gas from a gas stove.

There are other cases that I remember indistinctly, but I cannot find them except by looking the records through. I find in each annual report the number during the year from suffocation or aspyhxia; but the reports do not show the dates.

Truly yours,

EDWIN M. SNOW,

Sup't of Health.

CASES 115 and 116.

On the 28th day of September, 1880, I held an inquest on the bodies of Benjamin Hanna and Peter Dean. The persons named blew out the coal gas instead of turning it off, and were suffo-

cated while sleeping, at the Burnett House, in Stroudsburg, Pa. I think best to correct the statement that the gas was made out of coal. I always understood it was coal gas, but Mr. J. Shafer informed me after I had written that the gas was made of kerosene oil. I believe he is correct.

M. M. BURNETT,

May 18, 1883. *J. P.*

CASES 117 and 118.

OFFICE, BOARD OF HEALTH, ROOM NO. 9, COURT HOUSE,
INDIANAPOLIS, April 20, 1883.

Yours received. In reply would say, that about the first of October, 1880, a couple registered at the Pyle House, this city, and we understand blew out the gas without turning it off, before retiring; both were found in their bed in the morning insensible; the woman recovered, as we remember from the newspaper reports, and the man died. Messrs. Kregelo, whose card we enclose, shipped the body to Laporte, Indiana, on the first of October, 1880. The coroner of that date is out of the city—he would know something about it.

Truly yours,

E. S. ELDER.

OFFICE, C. E. KREGELO & WHITSETT, FUNERAL DIRECTORS,
77, 79 and 81 North Delaware Street,
INDIANAPOLIS, May 19, 1883.

Your favor received this A. M. The report, so far as Mr. Forester is concerned, is true. He and wife went to sleep in the Pyle House in this city; they left the gas turned on (coal gas.) When found in the morning he was dead; I was called and took charge of the remains; his wife, I understand, has since died, but not supposed from that cause. The Coroner held an investigation at the time, but records by some means have been lost; he not being in the city at this writing it is impossible for me to send you copy of same or give any definite information; our present coroner endeavored to find some records of the case but was unable to do so. It only occurs on our books as a funeral account. Death caused by inhalation of gas. I will make further inquiry and should I learn anything will inform you at once.

Respectfully yours,

CHAS. E. KREGELO.

CASE 119.

DEPARTMENT OF HEALTH,
CHICAGO, April 19, 1883.

In the case of John Hopkins, who died May 7, 1881, the following is a transcript of the coroner's inquest. Cause of death: Asphyxia, caused by escaping gas from a burner in his bed-room; the deceased having been to work on said burner, trying to make it turn so as to give him a chance to light it, said burner having evidently got loose during the night and let the gas escape, causing said death. The gas used in this city is coal gas.

Respectfully,

M. K. GLEASON, M. D.,

Registrar.

CASE 120.

HEALTH DEPARTMENT,
ERIE, Pa., May 15, 1883.

In reply to your letter addressed to the Mayor of our city about the effects of coal or water gas, I would state that within the last eight years, since I kept our death register, no fatal case of poisoning in these cases was reported. Two years ago I found ten persons stupefied by coal gas, but all recovered. There is no law against the use of it in our State.

Very respectfully yours,

ED. W. GERMER,

Health Officer.

CASES 121 and 122.

OLD COLONY STEAMBOAT COMPANY, (Fall River Line,)
Agent's Office, 70 and 71 West Street,
NEW YORK, May 11, 1883.

Referring to your favor of the 8th instant we will say that two persons were found in a stateroom on steamer Providence, May 5, 1882, insensible from the inhalation of illuminating gas. Both recovered. The gas was coal gas. From the statements of the parties we concluded the gas was turned on by one of them during the night.

Yours truly,

BORDEN & LOVELL, *Agents.*

CASE 123.

CITY CLERK'S OFFICE,
NEWPORT, R. I., May 19, 1883.

Yours of 17th at hand. Mr. James H. Langley, an elderly and very respectable citizen of this place, died at the residence of his son-in-law, Mr. Albert Caswell, a druggist, in Jersey City,

about the time you mention, as is understood, from the effects of the inhalation of gas in his stateroom on the steamer "Bristol," if I understand aright, while on his way to New York. He was removed, upon his condition being discovered, to a hospital (in Chambers street, I believe), and after being treated there was taken by his friends to Jersey City, where he died, something like ten days from the time of his leaving this city. This is all the information I have at command in relation to the case, Mr. Caswell can probably give you more accurate particulars.

Yours very truly,

WM. G. STEVENS,

City Clerk.

OLD COLONY STEAMBOAT CO. (Fall River Line),
Agent's Office, 70 and 71 West Street,
NEW YORK, May 17, 1883.

Mr. James H. Langley was found in a stateroom on steamboat "Bristol," May 25, 1882, unconscious from inhaling coal gas (illuminating.) After partial recovery he died on or about May 31, 1882.

Yours truly,

BORDEN & LOVELL,

Agents.

CASE 124.

OFFICE OF THE
BOARD OF HEALTH AND VITAL STATISTICS OF HUDSON COUNTY,
JERSEY CITY, N. J., April 19, 1883.

In reply to your favor of the 17th inst., as to circumstances attending death of Annie Buck, October 12, 1882, I beg to inform you that the record states that she died from "suffocation by illuminating gas." There was no coroner's investigation; the case being clear, as examined into by our county physician, C. B. Converse, M. D. She was found dead in bed in the morning and the room full of ordinary street gas, carburetted hydrogen, is it not?

Yours truly,

C. J. ROONEY, JR.,

Clerk.

HUDSON COUNTY BOARD OF HEALTH,
JERSEY CITY, April 23, 1883.

I made a call at the Gas Company's office which supplies the gas to the residence of the Buck family, where Miss Annie Buck

died, and the gentleman in charge assured me that it is coal gas that is supplied to the house in question, and was at the time of death of Miss B.

Yours truly,

C. J. ROONEY, Jr.,

Clerk.

Hudson County Board of Health,
Jersey City, May 22, 1883.

In the case of Annie Buck, who died from inhaling illuminating gas the facts are these (supposed):

She went asleep, reading, and the gas is supposed to have been either blown out by a gust of wind, or to have gone out from inconstancy of the pressure. The cock was turned open. No evidence leading to supposition of suicide was obtained.

Yours truly,

C. J. ROONEY, Jr.,

Clerk.

CASE 125.

Batavia, N. Y., April 28, 1883.

In answer to yours of the 17th instant to Mr. Tompkins (Health officer), in regard to W. Toland inhaling coal gas, I have the honor to state that said Toland did not die, but came very near it. He stopped over night, November 18, 1882, at the Washburn House, and on going to bed he blew out the gas, but was discovered in time to save his life. Said Toland resides in Akron, Erie Country, New York. Has stopped at the Washburn House since, and says that in the future he will turn out the gas and not blow it out as before.

Respectfully,

PETER THOMAS,

Town Clerk and Registrar.

Town Clerk's Office,
Batavia, N. Y., May 1, 1883.

In reply to yours of April 30, I have the honor to state that Mr. Toland's illness was caused by coal gas.

Yours respectfully,

PETER THOMAS,

Town Clerk.

CASE 129.

BOARD OF HEALTH, 32 PEMBERTON SQUARE,
BOSTON, April 17, 1883.

It appears from the records in this office that Frank Hahse died in Boston March 19, 1883, by suicide by inhaling illuminating gas.

Very respectfully,

C. E. DAVIS, JR.,

Clerk.

BOARD OF HEALTH, 32 PEMBERTON SQUARE,
BOSTON, May 9, 1883.

The answer to your inquiry about the death of Frank Hahse has been delayed by reason ot the absence from town of Dr. Draper, the medical examiner, who made the examination; he reports the result of his inquiries to be as follows: That Frank Hahse came to his death on the 19th of March last by inhaling illuminating gas (coal), in his room at the International Hotel in this city, with suicidal intention; he says there was no inquest, the cause and manner of the death being plain. Hahse shut himself in his room and was found the next day on his bed, unconscious, with a rubber tube, whose free end was near his mouth, the other end being fastened to a gas burner from which gas was escaping; physicians were summoned, but their efforts for restoration were ineffectual. Letters found upon him showed him to be financially embarrassed.

Very respectfully,

C. E. DAVIS, JR.,

Clerk.

CASE 130.

IOWA STATE BOARD OF HEALTH,
Office of the Secretary,
DES MOINES, April 30, 1883.

Yours of the 27th instant just to hand. The gas was common illuminating gas. The dispatch as published was as follows, viz.:

OSKALOOSA, April 6.

Mrs. Nancy Braden come in from the west on the cars, went to room 53, Downing House, turned off the gas and turned it on again, as the cock had no catch, or blew it out. Found dead in the morning.

Yours truly,

R. J. FARQUHARSON,

Secretary.

CASES 131 and 132.

MAYOR'S OFFICE,
ROCHESTER, N. Y., April 14, 1883.

Your letter of yesterday has just been handed me. Mr. McCormick did not die; both he and his wife were discovered at 11 A. M. (I think it was on Tuesday last), in an unconscious condition. The gas inhaled by them was from their parlor stove, the top of which had been at night (by mistake evidently) left partly open; Mrs. McCormick was soon restored; her husband did not regain consciousness until about fifteen hours after the discovery was made; both of them are now considered as out of danger; they were attended by Drs. E. M. Moore and David Little, and I think either of them will gladly give you additional information should you desire it.

Truly yours,

C. R. PARSONS,

Mayor.

CASES 134 and 135.

BLACKSTONE, Mass., April 27, 1883.

The enclosed was received. In answer have to say that no such persons have died in this town from the inhalation of coal gas; and further, I am unable to learn that any such persons as W. H. Metcalf and son have ever lived here.

Truly yours,

AMERICUS WELCH,

Chairman, Selectmen.

CASE 136.

BATH, Me., May 9, 1883.

Answer to your inquiry of the 8th, say: The manner or cause specified does not appear on the records of deaths as kept by Superintendent of Burials.

Respectfully,

J. C. LEDYARD.

CASE 139.

ALBANY, May 9, 1883.

Having made a careful examination of the death records I fail to find the name of Esther Burton. If she died in this city they made no returns.

Yours, &c.,

EDWARD H. LONG,

Secretary to Board of Health.

CASES 142 and 143. Office of the Board of Health, Worcester, Mass., June 20, 1883.

Artemus Ward and wife died of asphyxia from the inhalation of anthracite coal gas. There was no official investigation by post mortem examination. The coroner viewed the bodies, and if I remember right, that was all.

Yours most respectfully,
R. WOODWARD.

"C." THE PRODUCTION OF EACH KIND OF GAS IN NEW YORK AND BROOKLYN.

The efforts made by me to secure a full account of the production of illuminating gas in New York and Brooklyn have been nearly fruitless. The fourth paper in appendix "C," shows that the production of but three of the companies of this city has been received. Most of the New York companies have declined positively to give any information in the matter, and apparently for the reason that they regard this kind of information in the light of a business secret.

"D." THE PROHIBITION OF WATER GAS BY LAW.

So far as can be ascertained after due inquiry, but two States have any legislation regulating the quality of illuminating gas; these are New Jersey and Massachusetts.

New Jersey: In 1876 the Legislature of this State passed an Act entitled "An Act to authorize the formation of gaslight corporations and regulate the same." The greater part of this Act is taken up with the mode of incorporation, amount of capital stock, election of directors, &c. But one section—Section 18, deals with the quality of gas; it reads: "That the quality of gas supplied by any company organized under this Act shall be, with respect to its illuminating power, such as to produce from an English parliamentary standard argand burner for sixteen candle gas, consuming five cubic feet of gas an hour, a light equal in intensity to the light produced by not less than fourteen sperm candles of six to the pound, each burning one hundred and twenty grains an hour; and such gas shall, with respect to its purity, be so far free from sulphuretted hydrogen that it shall not discolor paper imbued with acetate of lead, when these tests are exposed to a current of gas, issuing for thirty seconds under

a pressure of five tenths of water." It will be seen by a perusal of this section that the amount of carbonic oxide was not at this time considered. In the year 1877 this section was amended by adding, "and shall not contain more than one per centum of carbonic acid gas, nor more than two per centum of carbonic oxide gas, nor more than ten per centum of hydrogen gas, under a penalty of one hundred dollars a day for each and every day that the gas supplied is not in accordance with the requirements of this act, to be sued for and recovered, with costs of suit, on complaint, in any court of competent jurisdiction; the one half of such penalty to be paid into the treasury and for the use of the town or city where the works of such company are located, the other half to the complainant." In 1878 and 1879 this Act was further amended, without, however, changing this Section 18. In 1883 an Act passed both houses of the Legislature, Assembly bill No. 27 (Senate amendment), by which it was provided that gas "shall not contain more than eight per centum of carbonic oxide gas." This bill was not approved by the Governor, and, therefore, failed to become a law. Another bill, known as Assembly bill No. 28, was introduced during the session of 1883, relating to gas, but seems to have progressed no further. From the best information I am able to obtain the eighteenth section of the Act of 1876 as amended in 1877, is now in force in the State of New Jersey. By the terms of this section gas "shall not contain more than one per centum of carbonic acid gas, nor more than two per centum of carbonic oxide gas, nor more than ten per centum of hydrogen gas." It will be remembered that the analysis of Prof. Remsen shows that in Brooklyn water gas contains 28.25 per cent., and coal gas 7.9 per cent. of carbonic oxide, and 30.3 per cent., and 50.2 per cent., respectively, of hydrogen.

The present position of the laws of New Jersey in reference to the gas question has been most difficult to ascertain; one excellent authority informed me that there was no statute on the subject and never had been; while still another reported that there had been a law but it was repealed. Mr. Stephen C. Betts, Law Librarian of this city, has examined the matter for me and has compiled the laws which will be found in full in the Appendix. I also communicated with Dr. E. M. Hunt, Secretary of the New Jersey State Board of Health, expressing the view of the present status of the law substantially as I have given it here, and received from him the following reply:

The Act, I believe, stands as you find it. Last year two bills, Assembly bills 27 and 28, related to gas; 27 got before the Governor but he did not sign it because there was a conflict between it and 28, and some doubt as to which passed. I find copies of these on permanent file in the State Library; 28 sought to repeal the restrictive former Acts.

Truly yours,

E. M. HUNT.

I herewith enclose the copies you desire in order that you may have all the legislation last winter had or attempted. As the bills did not pass the approval of the Governor, no State certificate could be given of them as law, but Mr. Dallas Reeves, the Registrar of Vital Statistics, who has copied them, or myself could, before a Notary Public, certify their correctness.

Very truly yours,

E. M. HUNT.

TRENTON, July 5, 1883.

Massachusetts: The public statutes of Massachusetts contain a chapter known as Chapter 61, on the inspection of gas and gas meters, which will be found in full in the Appendix. Section 14 contains the following language with reference to the quality of the gas to be furnished: "When the gas of any company is found on three consecutive inspections to give less light than fifteen standard English candles, or to contain more than twenty grains of sulphur or ten grains of ammonia per hundred cubic feet of gas, or more than ten per cent. of carbonic oxide or any sulphuretted hydrogen, a fine of one hundred dollars shall be paid by such company to the city or town supplied by it." Brooklyn coal gas contains 7.9 per cent., and water gas 28.25 per cent. of carbonic oxide.

"E." AN OPINION AS TO THE RELATIVE DANGEROUS PROPERTIES OF THE TWO KINDS OF ILLUMINATING GAS.

The relative danger to life has been inquired into as regards the two kinds of illuminating gas used in this city, and in this Report and its Appendix will be found every available fact and opinion that will tend to inform the mind of your Committee on this branch of the question. The opinion of Prof. Ira Remsen has already been given in connection with the analysis of the two gases. In the Appendix will be found the opinions of Professor Shepard and Dr. Abbott, who regard water gas as the more dangerous; and those of Professors Chandler and Morton which take the ground that both are equally dangerous. Opinions of other chemists, physicians and experts will also be found in the Appendix.

Inquiries have been made of the following sanitary authorities for information respecting laws regulating the quality of gas, and deaths or injuries due to its use, and for any other facts bearing upon the subject.

To State Boards of Health of New York, New Jersey, Massachusetts, Rhode Island, Connecticut, Illinois, Indiana, Michigan, Wisconsin, Iowa, California, Louisiana, Kentucky, Mississippi, Nebraska, Alabama, Arkansas, Colorado, Delaware, Texas, Maryland, Minnesota, South Carolina, West Virginia.

These are the only States known to have Boards of Health.

To City Boards of Health of New York, Philadelphia, Boston, Baltimore, Washington, Chicago, St. Louis, New Orleans, Buffalo, Rochester, Albany, Jersey City, New Haven, Hartford, Providence, Springfield, Worcester, San Francisco, Louisville, Ky.; Savannah, Ga.; Charleston, S. C.; Detroit, Mich.; Milwaukee, Wis; Wilmington, Del.; Dayton, Ohio; Omaha, Neb.; Richmond, Va; Tallahassee, Fla.; Kansas City, Mo.; Portland, Ore.; Burlington, Vt.; Memphis, Tenn.; Pittsburg, Pa.; Cincinnati, O.; Newbern, N. C.; Portland, Me.; Topeka, Kan; Scranton, Pa.; Reading, Pa.; Cleveland, Ohio; Wheeling, W. Va.; Jacksonville, Fla.; Natchez, Miss.; Wilmington, N. C.; Raleigh, N. C.; Newark, N. J.; Atlanta, Ga.; Augusta, Ga.; Sacramento, Cal.; Trenton, N. J.; Paterson, N. J.; Minneapolis, Minn.; Terre Haute, Ind.; Mobile, Ala.; Nashville, Tenn.; Knoxville, Tenn.;

Salem, Ore.; Petersburgh, Va.; Salt Lake City, Utah; Peoria, Ill.; Quincy, Ill.; Fort Wayne, Ind.; Davenport, Iowa; Dubuque, Iowa; Covington, Ky.; New Bedford, Conn.; Lynn, Mass.; Elmira, N. Y.; Troy, N. Y.; Toledo, Ohio; Erie, N. Y.

To the sanitary authorities of the following foreign cities:

London, Paris, Berlin, Vienna, St. Petersburgh, Liverpool, Glasgow, Birmingham, Marseilles, Lyons, Rome, Madrid, Edinburgh, Havana, Mexico, Rio de Janeiro, The Hague, Stockholm, Copenhagen, Dublin, Brussels, Leipsic, Zurich, Quebec, Montreal, St. Johns, N. B.; Toronto.

The following are the circular forms used in prosecuting this inquiry:

DEPARTMENT OF HEALTH.

OFFICE OF THE COMMISSIONER,
MUNICIPAL DEPARTMENT BUILDING,
Room 21,

BROOKLYN, N. Y., April ...., 1883.

DEAR SIR:

It is reported that ....
....
died in your city.......................... ....from the inhalation of................ .... Will you be kind enough to inform me if this is the fact, and if so, the kind of gas, as "coal gas," "water gas," etc? If there was any official investigation, as by coroner or otherwise, please send me a copy of the evidence taken. I will cheerfully pay any expense connected therewith.

Respectfully,

J. H. RAYMOND,
Commissioner.

DEPARTMENT OF HEALTH.

OFFICE OF THE COMMISSIONER OF HEALTH,

BROOKLYN, N. Y., U. S. A., April 13, 1883.

DEAR SIR:

The Common Council of this City has ordered an investigation into the relative ill effects of the inhalation of coal gas and water gas, and I have been requested to obtain information bearing upon this question. May I ask your kind attention to the following list of questions, answers to which will be thankfully received:

What has been the number of deaths, by years, from the inhalation of coal gas since its introduction into your city?

Years ....

Deaths ....

Years ....

Deaths ....

What has been the number of deaths, by years, from the inhalation of water gas since its introduction?

Years ....

Deaths ....

What has been the yearly consumption of water gas in your city since its introduction?

Years ....

Consumption of Water Gas ....

What has been the yearly consumption of coal gas during the same period?

Years ....

Consumption of Coal Gas ....

Years ....

Consumption of Coal Gas ....

Has the use of water gas (or any other gas containing more than ten per cent. of carbonic oxide) or coal gas been prohibited by law in the State of...... ....and if so, when?

Yes or No. Dates, if any...

Has the use of either gas been prohibited in any of the cities of the State of.. and if so, by what cities and when?

Names of Cities ....

Dates, if any...

Any information is invited which bears upon the peril to HEALTH by either of these gases, such as cases of gas poisoning when the results have not been fatal.

Any official analyses of either of these gases known to you is requested.

Very respectfully,

J. H. RAYMOND, M. D.,

Commissioner of Health.

To the Secretary of the Board of Health of.......................................

In closing this report let me say that in order to throw light upon the questions raised by your Committee I have sought to embody herein every useful fact and all the available literature brought out during the investigation. These have been placed in the Appendix and arranged so as to correspond with the principal sub-divisions of the body of the report.

By the Commissioner,

R. M. WYCKOFF, M. D.,

Secretary.

APPENDIX.

INDEX TO APPENDIX.

E, .. 4.—Opinion of Dr. Charles U. Shepard, Jr., and others, in a pamphlet entitled, "Water Gas is Poisonous."

E, .. 5.—From *American Gaslight Journal.* The illuminating gas of New York City, by Professor E. G. Love.

E, .. 6.—From *American Progress.* Poisonous illuminating gas.

E, .. 7.—Affidavit of John B. Chichester, gas engineer, on effects of inhaling gas.

E, .. 8.—Affidavit of Henry P. Morgan, President Nassau Gaslight Co., on effects of inhalation of gas.

E, .. 9.—Pamphlet. The Fulton Municipal Gas Co. Water gas is not more dangerous than coal gas.

E, .. 10.—Pamphlets. Fulton Municipal Gas Co.

E, .. 11.—Pamphlet. Water gas—is it more dangerous in actual use than coal gas? A. O. Granger, Philadelphia.

E, .. 12.—Pamphlet. An open letter to the *American Gaslight Journal.* A. O. Granger, Philadelphia.

E, .. 13.—Report to the Joint Committee on Gas. Philadelphia.

E, .. 14.—Report of Joint Committee on Finance and Light. Richmond, Va.

E, .. 15.—Report in favor of making coal gas under municipal control, Richmond, Va.

E, .. 16.—Report of gas inspection. Massachusetts.

E, .. 17.—Some facts and considerations relative to the gas question in Detroit. By the Detroit Gaslight Co.

E, .. 18.—Water gas. A dangerous poison. Anonymous.

E, .. 19.—Illuminating water gas proved a deadly poison. The prediction of Professor Henry Morton and others.

E, .. 20.—Have you seen their "Scare Crow?" Anonymous.

E, .. 21.—A summary of cases reported, in the English and American law reports, relating to the injury of person and property from the escape and explosion of illuminating gas. Prepared by Stephen C. Betts, law librarian.

E, .. 22.—Illuminating gas in its relations to health. By Edward S. Wood, M. D. Transactions of the American Public Health Association, vol. iii, 1876.

Bibliography of Water Gas. Communicated by Mr. Thos. B. Fogarty.

APPENDIX A. PAPER 1.

SANITARY DEPARTMENT, 1 MONTROSE STREET,
GLASGOW, May 23, 1883.

DEAR SIR :

In reply to your circular of 13th April. We know nothing of any gas here but coal gas. Fatal accidents from inhalation of coal gas have been practically unknown. Explosions are not infrequent.

The following is an analysis of Glasgow gas made last year by Professor Frankland, F. R. S. of London, for parliamenatry purposes :

Luminiferous hydrocarbon (=13.73 olefiant gas)........	12.36
Marsh gas....................................	41.37
Hydrogen.....................................	28.49
Carbonic oxide................................	9.60
Carbonic acid.................................	.55
Oxygen.......................................	.66
Nitrogen......................................	6.97
	100.00

I am, dear sir, yours truly,

JAS. B. RUSSELL, M. D.

APPENDIX A. PAPER 2.

Average of fifteen chemical tests made during six months ending June 1, 1883, of the coal gas manufactured by the Cleveland Gaslight and Coke Co.:

NH_3........0.37 per cent., or 37.100 of one per cent.
SH_2........0.42
CO_2.. .....0.36
CS_2........0.21
Illuminants ..4.26
O...........0.23
C O.........0 22

Persons inhaling coal gas will be prostrated, but are easily resuscitated in the fresh air with stimulants without injury.

G. C. ASHMAN,

Health Officer.

APPENDIX B. PAPER 1.

In the examination of the records of the Health Department of Brooklyn for deaths from illuminating gas it was necessary to inspect 290,545 death certificates, that being the number recorded from January 1, 1848, to June 1, 1883.

It was found that 538 of these were entered as due to suffocation from various causes, not including croup, diphtheria, etc.; the greater part of these were recorded simply as "suffocation" or "asphyxia" without any indication of how it occurred.

A further search was then made in the inquisitions of the coroners, and here additional information was obtained; after all means were exhausted there were still not less than 293 deaths from "asphyxia" or "suffocation" without any other assignable cause; of these 145 were under 1 year of age and probably were either still births or died very soon after birth from debility, or injury received during birth. 70 have no age given; these are principally recorded without a first name and are, therefore, presumably infants dying before they received a name; between 1 and 5 years are 28 dying from no other cause than "asphyxia" or "suffocation." I think, however, we are justified in classing them with those who died from some such cause as bronchitis or croup, probably not from gas. This would leave 50 deaths recorded as due to "asphyxia" or "suffocation" in persons between the ages of 5 and 80 years. These cases are given in detail, and it may be that at some future time the cause of the "asphyxia" or "suffocation" may be learned, but at the present time it can be but mere conjecture.

List of Deaths from Suffocation in Brooklyn during the period from January 1, 1848. *to June* 1, 1883.

DATE.	NAME.	AGE.	CAUSE OF DEATH AND LOCATION.
January 15, 1848	Dennis I. Sweeney		Accidental suffocation.
March 3, 1849	David Henard		" "
Jaunary 12, 1850	Child of J. T. Moore		Asphyxia.
June 8, 1850	Frederick Erning	32 years	"
February 15, 1851	Joseph Easton	10 years	"
October 18, 1851	Hazard Moore		"
February 21, 1852	Ellen Scanland		"
May 8, 1852	James Hill		Accidental suffocation.
May 15, 1852	Thomas Reynolds		" "
February 12, 1853	Jane Thompson	63 years	" "
February 19, 1853	Mary Morgan		Asphyxia.
March 19, 1853	James Boyle		"
September 3, 1853	Child of Mrs. Roma		"
October 15, 1853	Child of Mrs. Stanler		"
November 12, 1853	Child of Mrs. Flynn		"
March 1, 1854	Mary Canton	4 months	"
March 25, 1854	Alfred Russell	4 months	Congestion, inhalation of noxious gas.
June 1, 1854	David Anderson	12 years	Asphyxia.
August 26, 1854	Peter Egan	4 hours	"
October 1, 1854	David Morehaup	5 days	"
November 12, 1854	Robert Sproule	12 hours	"
February 28, 1855	Sarah Fox		Suffocated.
February 8, 1855	John Suffern	6 months	"
May 12, 1855	Mary Hennessy	2 weeks	Overlain.
July 21, 1855	Mary Goldens	15 hours	Asphyxia.
September 2, 1855	Michael Cummings	4 hours	"
October 16, 1855	Thomas Higgins	1 month	"
November 3, 1855	Joseph Coffee	2 hours	"
December 20, 1855	Mary McGaghey	4 hours	"

List of Deaths, &c., from January 1, 1848, *to June* 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
January 11, 1856	Jose de Olivera	35 years	Asphyxia by charcoal.
January 11, 1856	Joaquin Lopez	25 years	" "
January 11, 1856	Antonio Gomez	15 years	" "
January 11, 1856	Jose de Cruz Braga	38 years	" "
January 11, 1856	Child of Mrs Brower	1 hour	Asphyxia.
February 19, 1856	Elizabeth Hudson	81 years	Suffocation.
April 8, 1856	William Lee	2 hours	Asphyxia.
July 15, 1856	Child of Mrs Hughes	6 months	"
July 15, 1856	Child of Mrs. Henry	...	"
July 24, 1856	Child of Mrs. Blane	3 hours	"
August 30, 1856	James Rugles	1 day	"
September 16, 1856	Julia Mansfield	1 day	"
September 21, 1856	Mary Donnagen	1 day	"
October 20, 1856	Mary Dillon	1 year	"
November 21, 1856	Patrick McCormick	1 month	"
November 24, 1856	Robert Howe	1 month	"
December 6, 1856	Rebecca Fasl	50 years	"
February 11, 1857	Bridget Farrell		"
February 11, 1857	Caroline B. Marion	28 years	151 Sands street, suffocated.
February 13, 1857	Margaret Flanagan		Asphyxia.
April 27, 1857	Margaret Collins	30 years	Strangled.
May 17, 1857	Caroline J. Scranton	5 months	Accidental suffocation.
May 27, 1857	——— Fegan	1 hour	Asphyxia.
June 2, 1857	Ganielle C Bennett	4 months	"
June 21, 1857	Mary A. M. Forder	10 years	Suffocated in throat by foreign body.
August 11, 1857	Mary Langfore	21 days	Suffocation.
August 23, 1857	Jos. A. Daton	1 month	Asphyxia.
September 4, 1857	Margaret Clynch	1 month	Suffocation.
October 6, 1857	Child of——Newsam		Asphyxia.
October 9, 1857	Francis A. Barnaby	$3\frac{1}{2}$ years	Suffocation, 191 Atlantic street.
October 9, 1857	Geo. W. Millay	7 years	" "

List of Deaths, &c., from January 1, 1848, *to June* 1, 1883.—Continued.

DATE.	NAME.	AGE.	CAUSE OF DEATH AND LOCATION.
October 17, 1857	Bardell Horn	25 years	Bank of earth.
October 17, 1857	Henry Berky	33 years	"
October 17, 1857	Adam Beigle	38 years	"
October 17, 1857	Christ. Haberle	52 years	"
October 27, 1857	Thomas W. Hudson	1 year	Bean in throat.
November 12, 1857	Brainerd Malone	1 month	Asphyxia, 4 Tiffany place.
December 14, 1857	Chas. B. Bryant	14 years	" Bond street.
October 26, 1857	Margaret Tracy	4 months	Suffocated.
January 9, 1858	Mary Monahan	2 months	Asphyxia.
January 19, 1858	George Wick	5 years	Suffocated, Oxford street.
January 19. 1858	John W. Green	5 years	" Concord street.
January 19, 1858	Henry Plass	10 years	" York and Jay streets.
January 20, 1858	Henry Le Blane	7 years	" 186 Nassau street.
January 20, 1858	Stephen Bloomfield	6 years	" 237 Gold street.
January 28, 1858	Child of E. Terry		Asphyxia, 6 Remsen street.
March 15, 1858	James McGough		Suffocation, Greenpoint avenue.
March 26 1858	Unknown child		Strangulation, foot of South Seventh street.
April 5, 1858	Harry King		Suffocation, Bond and Dean streets.
April 9, 1858	Child of——Beebe	8 days	Asphyxia, 32 Bond street.
April 13, 1858	Geo. Brennan	7 months	" 97 South Second street.
May 15, 1858	Wm. McKenzie	2 days	" Greenpoint avenue.
July 10, 1858	Thomas Welch	16 years	" 243 Plymouth street.
August 5, 1858	Joseph Gerung	2 months	Accidental suffocation, 91 Meserole street.
August 19, 1858	Catharine Hogan	2 months	Suffocation, Bridge row.
October 24, 1858	Edward Taylor		Asphyxia, 316 Atlantic.
November 3, 1858	Viola Farrington	15 days	Suffocation, 187 Prospect.
November 6, 1858	Ellen Orr	1 day	Asphyxia, 42 Main street.
December 1, 1858	——— Wright		" 38 First place.
December 16, 1858	Eliza Meyers	3 days	Suffocation, 92 Sands street.
December 27, 1858	——— Anderson		Asphyxia, 356 Hicks street.
January 13, 1859	Patrick Slatty	25 years	Suffocation, Amity street.

List of Deaths, &c., from January 1, 1848, *to June* 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
January 16, 1859	Edward Delaney	40 years	Suffocation, Amity street.
January 29, 1859	Christopher Bleimer	2 years	" 24 Metropolitan avenue.
February 6, 1859	Elizabeth Gill	27 years	" Fulton street and Elm place, fire.
February 6, 1859	Ellen E. Gill	2 years	" " " "
February 6, 1859	Mary E. Gill	6 years	" " " "
February 6, 1859	Ann Regan	42 years	" " " "
February 14, 1859	—— McCormick		Asphyxia, 38 State street.
February 8, 1859	—— Harris		" 20 Kent avenue.
February 25, 1859	Elizabeth DeKalb	4 months	Suffocation, 402 Hudson avenue.
March 22, 1859	—— Dunn		Asphyxia, 47 James street.
April 21, 1859	Kunigunde Dory	9 months	Suffocation, Debevoise street.
May 29. 1859	Patrick Mealer	47 years	Strangulation, Hoyt and Butler streets.
June, 2, 1859	Peter Warner	2 days	Suffocation, 115 South Sixth street.
June 21, 1859	—— Rogers		" 298 Degraw street.
June 27, 1859	Daniel Alcorn	44 years	" 147½ Water street.
June 27, 1859	James McGinnis	48 years	" 150 Plymouth street.
June 28, 1859	Christian Steinwedell	37 years	" 73 Scholes street.
July 9, 1859	Samuel H. Lurkey	2 years	" 52 Bushwick avenue.
July 6, 1859	—— Roder		Asphyxia, Division avenue.
August 7, 1859	Abraham Hinchman	53 years	Suffocation, Fulton street and Clove road.
August 8, 1859	Geo. Volkemaner	10 months	" Smith and Johnson streets.
August 9, 1859	—— Tompkins		Strangulation, Third Precinct Police.
August 18, 1859	Edward Hodgetts	2 months	Suffocation, 203 South Third street.
August 26, 1859	James Haggerty	45 years	" Myrtle and Kent.
September 2, 1859	Unknown man		" Atlantic Dock
September 17, 1859	Ellen Clark	2 months	" 211 Gold street.
September 27, 1859	Catharine Galliger	4 years	" 154 Navy street.
October 16, 1859	—— Welch		Asphyxia.
October 22, 1859	Blanche Dougherty	2 years	" Graham and DeKalb.
October 27, 1859	Earnest A. Heide		" South Fifth street.
November 13, 1859	Chas. Jacobi	1½ months	Suffocation, 29 Myrtle avenue.

List of Deaths, &c., from January 1, 1848, *to June* 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
November 14, 1859	Wilhelm Stachtman	1 day	Asphyxia, Remsen street.
November 18, 1859	Emma Lamburgh	1 month	Suffocation, 386 Hudson avenue.
February 16, 1860	—— Duffy	2 days	" Dickson's alley.
February 23, 1860	Maria Steinhauer	3 months	" Morrell street.
February 3, 1860	Christiana Scharfenberg	$3\frac{1}{2}$ years	" 129 Fulton street.
April 21, 1860	Mary E. Boyl	14 days	" Flushing avenue.
May 14 1860	Joseph Schwing	52 years	Asphyxia, Moore street.
May 27, 1860	Hugh Barton	4 years	" 62 Wyckoff street.
June 29, 1860	—— Vallentine		" 9 Montrose avenue.
August 1, 1860	—— Everett		" 127 Myrtle avenue.
September 2, 1860	Mary E. Barr	1 month	Suffocation, North Seventh street.
September 2, 1860	Joseph Barnett	$7\frac{1}{2}$ months	" 122 Remsen street.
September 12, 1860	—— Hobart	1 day	Asphyxia, 182 Flatbush avenue.
September 14, 1860	Edward Flaherty	28 years	Suffocation, Hicks and Coles streets.
September 14, 1860	Unknown child		Strangled, DeKalb avenue.
September 17, 1860	Chas. Schaffer	29 years	Asphyxia, 222 Jay street.
September 20, 1860	—— Lane		" 24 Hampden street.
September 26, 1860	Chas B. Stevens	$1\frac{1}{2}$ years	Inhalation of lead, Clermont avenue.
October 6, 1860	Mary Elizabeth	15 years	Suffocation, 98 Vanderbilt avenue.
November 28, 1860	Elizabeth Holman	2 months	" 2 Sedgwick street.
December 3, 1860	—— Schwab		Asphyxia, 36 Marshall street.
December 16, 1860	—— Anderson		" 210 Fulton street.
January 3, 1861			" 3 Henry street.
January 12, 1861	Ellen Sheehan	4 months	Suffocation, 6 Dennet place.
January 29, 1861	Louisa Coon	1 month	" 5 Furman street.
February 6, 1861	William Walker	2 months	" 233 Water street.
February 26, 1861	Walter Wardlow	3 years	" 87 President street.
March 5, 1861	—— Meyers		" 249 Navy street.
March 17, 1861	Francis Needham	3 days	Asphyxia, 222 Water street.
March 21, 1861	Catharine Hetell	10 days	Suffocation, 298 Myrtle avenue.
March 26, 1861	Mary Donahue	2 months	" Classon and Pacific street.

List of Deaths, &c., from January 1, 1848, to June 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
June 19, 1861	Eugene O'Connell	40 years	Suffocation, 53 Adams street.
June 22, 1861	Ada Philpitt	1 day	Asphyxia, 87 North First street.
July 4, 1861	——— Donnelly		" Franklin avenue.
August 1, 1861	Honora Connor		" 23 James street.
August 24, 1861	——— Bartow		" 287 Caroll street.
September 1, 1861	Henry A. Kelly, Jr	13 years	" 118 Willow street.
September 16, 1861	Honora Gleason	1 day	" 49 Butler street.
October 7, 1861	Ellen Diver	21 days	Suffocation, 215 Front street.
October 7, 1861	William Tynan	2 years	Asphyxia, 217 Columbia street.
October 7, 1861	John R. Kanz	7 months	Suffocation, 47 Meserole avenue.
October 10, 1861	——— McLoughlin		Asphyxia, Furman street.
October 11, 1861	Eli B. W. Young	1 day	" DeKalb avenue.
October 14, 1861	William Whalen	2 years	Suffocation, Third Police Precinct.
October 15, 1861	Francis Tiller	3 years	Asphyxia, Flushing avenue.
October 17, 1861	Elizabeth Hagan		" Dean street and Flatbush avenue.
November 15, 1861	James Carly	55 years	Suffocation, Atlantic Stores.
November 17, 1861	——— Holton		Asphyxia, 23 Carlton avenue.
November 23, 1861	James Wharty	1 day	" 110 North Sixth street.
December 8, 1861	——— Woods	21 days	Suffocation, Grand avenue.
December 16, 1861	Alex. M. McAuley	6 months	Asphyxia, 333 Powers street.
December 23, 1861	Patrick H. Mooney	1 month	Suffocation, 11 Classon avenue.
January 12, 1862	Elizabeth Firman	5 months	" 3 Columbia street.
January 20, 1862	Catharine Hayes	5 days	Asphyxia, 101 Baltic street.
January 25, 1862	Andrew Riley		Preternatural birth, 208 Columbia street.
February 14, 1862	Emma F. Leonard	4 years	Suffocation, Fifth avenue and Fourteenth street.
February 20, 1862	——— Stewart		Preternatural Birth. 476 Columbia street.
February 28, 1862	Lavinia Leamon	4½ years	Suffocation, Fifth avenue.
March 23, 1862	Rose A. Grant	1 month	Asphyxia, Cook street.
April 16, 1862	Bertha Wideserweiler	1 day	" 3 Meserole avenue.
May 3, 1862	John Blackley	16 days	" Classon avenue.
June 1, 1862	——— Betz		" North Seventh and Sixth streets.

List of Deaths, &c., from January 1 1848, *to June* 1, 1883.—Continued.

Date	Name.	Age.	Cause of Death and Location.
June 3 1862	James Skally	11 years	Suffocation, 13 North Seventh street.
June 18, 1862	Rose B. Sweetman	4 months	" 33 Franklin avenue.
July 27, 1862	Michael Finger.	30 years	" 10 Remsen street.
August 24, 1862	John Lett	1 month	" 93 Graham avenue.
August 30, 1862.	——— Todd		Asphyxia, 269 Adams street.
September 12, 1862	Francis Reed	1 day	Premature birth, Baltic street.
September 12. 1862	Joseph Reed	1 day	Premature birth, Baltic street.
September 13, 1862	Joseph O'Neil	7 months	Drowned in a wash tub, Bergen street.
October 10, 1862	Mary O'Connell		Asphyxia, 28 Debevoise street.
October 20, 1862	——— Bileboch	1 day	Suffocation, 14 Oxford street.
October 26, 1862	Geo. Davis	5 days	Asphyxia, 59 Fulton street.
October 26, 1862	Philip Recker	$6\frac{1}{2}$ years	Suffocation, Broadway.
October 28, 1862	Elizabeth Rousen	$2\frac{1}{2}$ months	" 196 Hamilton avenue.
October 31, 1862	——— Daly		Asphyxia, 243 South Fourth street.
October 31 1862	Barbara Smith	1 day	Suffocation, 196 Scholes street.
November 29, 1862	John Shanley	1 day	Asphyxia, 299 Hudson avenue.
November 17, 1862	Timothy Fox	1 day	" Bond street
November 7, 1862	John H. Parttow	1 year	Abscess of throat, 100 York street.
November 29, 1862	James Shanley	1 day	Asphyxia, 299 Hudson avenue.
December 7, 1862	Emma Field	$6\frac{1}{2}$ months	Suffocation, 3 Baltic street.
December 12, 1862	——— Denning		Strangulation at birth, 37 Stanton street.
December 18, 1862	Margaret Megarer	1 day	Asphyxia, 88 Ewen street.
December 21, 1862	——— Murphy	1 day	Asphyxia at birth, Sixteenth street.
December 24, 1862	Adam Breuem	3 days	Accidental suffocation, Calyer street.
January 3, 1863	Christian Hans	49 years	Suffocation, 172 Meserole street.
January 5, 1863	Mary Pulvemiller	1 day	Asphyxia, Walton street.
January 11, 1863	Geo. Meyers	45 years	Suffocation, Greenpoint avenue.
January 16, 1863	Margaret Gilling	3 months	" Partition street.
January 17, 1863	John Black	1 day	Asphyxia, Flushing avenue.
January 28, 1863	Susanna E. C. Vanderhorst	7 years	" 163 Third street.
February 7, 1863	Richard McGrath	5 months	Suffocation, Bond street.

List of Deaths, &c., from January 1, 1848, *to June* 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
March 17, 1863	William Moore	9 months	Suffocation, Ninth Ward.
March 26, 1863	Harriett A. Holland	6 years	Asphyxia, 253 Grand street.
April 10, 1863	James Beekman	4 years	Suffocation by smoke, 51 Green Lane.
April 10, 1863	John McGinnis	64 years	Suffocation by foul air, 94 Carlton avenue.
April 10, 1863	John Donnelly	50 years	" "
April 11, 1863	John Heeny	19 years	Asphyxia from irrespirable gas while cleaning privy vault, 87 Carlton avenue.
April 11, 1863	Henry Beekman	2 years	Suffocation by smoke, 51 Green Lane.
April 19, 1863	Anna M. Barbarie	3 months	Suffocation, South Fourth and Eleventh streets.
April 22, 1863	Mathias Engler	4 months	" Lorimer street.
May 2, 1863	Patrick Loughlin	35 years	" Eighth Ward Station House.
June 2, 1863	—— Fowler		Asphyxia, 351 Fifth street.
June 9, 1863	—— Smith		" 364 Adelphi street.
June 10, 1863	Caroline Golder		" 13 Tenth street.
June 11, 1863	Mary Munson		" Bushwick avenue.
August 16, 1863	Abaloned Pede	4 months	Suffocation, Merciene street.
August 21, 1863	Martin Connelly	13 days	Asphyxia, 232 Pacific street.
August 23, 1863	—— Eaglebon		" 303 Carlton avenue.
September 29, 1863	Rosana Dougherty		" City Hospital.
October 13, 1863	Bridget Moran	1 day	Accidental suffocation at birth, 141 Plymouth St.
October 16, 1863	Thomas Sienman	3½ years	Suffocation, Franklin avenue.
November 20, 1863	Ann Bulkley	46 years	Asphyxia, City Hospital.
November 26, 1863	Sarah Townley	1 year	Suffocation, Myrtle avenue.
December 1, 1863	— Collins	1 hour	Asphyxia, 86 Columbia street.
December 3, 1863	Chas. Connely		Suffocation, Court street.
December 7, 1863	Mary Young	3 months	Asphyxia, 2 Willoughby street.
December 10, 1863	Adam Rosman	7 months	Suffocation, Bergen street.
December 16, 1863	James Furey	2 months	Accidental suffocation, overlain, 196 High street.
December 31, 1863	Alice Carr	2 months	Suffocation, 258 John street.
January 9, 1864	John A. Smith	4 months	" 5 Green Lane.
February 2 1864	Chas. A. Peterson	5 months	" 63 Main street.

List of Deaths, &c., from January 1, 1848, to June 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
February 5, 1864	Virginia Day		Asphyxia, 143 South Eighth street.
March 10, 1864	Harry Thonger		" 175 Conover street.
March 28, 1864	Patrick Shanley	30 years	Suffocation, Columbia street.
April 19, 1864	Mary E. Wilson	1 month	" by clothes, 23 President street.
April 24, 1864	Lizzie Peterson		Asphyxia, 34 Montrose avenue.
May 3, 1864	Harry Birdsall, Jr	$1\frac{1}{2}$ years	" 32 Taylor street.
May 13, 1864	Anna Delius	20 days	" 200 Fulton street.
May 20, 1864	Samuel A. Lane	1 day	" 90 Cumberland street.
August 21, 1864	John Quinn	1 day	" 147 North Seventh street.
August 23, 1864	——— Jackson		" Flushing avenue.
October 17, 1864	——— Scott		" 203 Fulton street.
November 4, 1864	John Turner	1 day	" Prospect stre t.
December 4 1864	Caroline Metzenger	5 months	Eruptive abscess in throat, 160 McKibben street.
January 3, 1865	——— Leight		Strangulation, Walworth street.
January 14, 1865	Elizabeth Hoffmann	5 hours	Asphyxia, 41 Remsen street.
January 17, 1865	——— Arcarilarius		" 70 Orange street.
January 19, 1865	——— Moore	1 day	" 93 Caroll street.
January 30, 1865	Sarah Marvin	1 day	" 19 Elm place.
February 17, 1865	Myro Van Buren	1 year	Suffocation, 228 Washington street.
March 16, 1865	Harry Evans	1 year	Asphyxia, 310 Atlantic avenue.
March 18, 1865	Morris Reilly	$1\frac{1}{2}$ years	Drowned in a boiler of water, 154 Butler street.
March 25, 1865	Elizabeth M. Ackerman	6 years	Suffocation by smoke, North Sixth and Second sts.
April 17, 1865	Catharine Cronin	4 days	Suffocation, Van Brunt street.
April 19, 1865	Frank Watson	3 months	" by bedclothes, 112 South First street.
April 23, 1865	Elizabeth Lang	2 years	" 112 McKibben street.
May 7, 1865	Mary C. Popls	2 years	Asphyxia, 97 Ninth street.
June 25, 1865	Rosanna Davis	1 month	Overlain, Schenck street.
June 30, 1865	Julia Joyce	1 day	Asphyxia, Dean street.
July 19, 1865	William Hammel		" 272 Hick street.
August 24, 1865	——— McGarry		" 26 Oxford street.
August 29, 1865	Henry A. Gittens	$1\frac{1}{2}$ years	" 139 Ninth street.

List of Deaths, &c., from January 1, 1848, *to June* 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
September 21, 1865	Frank Sidilinger	6 hours	Asphyxia, 14 Canton street.
September 28, 1865	Francis A. McAlister	5 years	" 10 Greenpoint avenue.
November 1, 1865	Daniel Keenan	35 years	Suffocation, North Sixth and Seventh streets.
November 21, 1865	—— Johnson		Asphyxia, Sedgwick street.
December 7, 1865	—— Kimball		" 22 Kent avenue.
December 14, 1865	Geo. W. Poole	5 months	" Troy avenue.
January 21, 1866	Anna Agne		" 80 Throop avenue.
February 18, 1866	Garry Kavanagh	25 years	Suffocation, Rush street.
February 21, 1866	—— Baldwin		Asphyxia, 94 Carlton avenue.
March 12, 1866	Mary Foley	$9\frac{1}{2}$ years	" 32 John street.
March 14, 1866	—— Ray		" 152 South First street.
March 19, 1866	Catharine Pursell	23 years	" 26 Prince street.
April 2, 1866	Ralph Pomeroy	63 years	" 65 South Tenth street.
April 11, 1866	Isadora Miller	3 years	" 49 Jay street.
April 17, 1866	—— Lovely		" 102 North Sixth street.
May 5, 1866	Susan M. Orange	1 year	" 1 Garibaldi Place.
May 17, 1866	Sylvester Cavanagh	1 day	" 1 Lee avenue.
September 14, 1866	Henry McNab	3 hours	" Bond street.
September 29, 1866	—— Folger		" Sixth street.
November 8, 1866	Patrick McDuff	1 day	" 68 North Seventh street.
November 21, 1866	Chas. Riefer	1 day	Suffocation, 136 Stagg street.
December 24, 1866	Henry Willis	1 hour	" 64 Lorimer street.
January 23, 1867	James Fallon	30 years	" by grain, 40 Dikeman street.
January 27, 1867	—— Dyge		Asphyxia, at birth, Ainslie street.
February 6, 1867	Unknown Boy		Strangulation, found dead in street, Gates avenue.
February 25, 1867	James McGee	30 years	Inhalation of gas, in distillery vat in Strykers Court.
March 20, 1867	Joseph Henkes	1 day	Asphyxia, Cook street
April 5, 1867	—— Ohl		" still birth, 100 Union avenue.
May 2, 1867	Elizabeth Segler	1 year	" drowned in a wash boiler, 30 Scholes street.

List of Deaths, &c., from January 1, 1848, *to June* 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
May 15, 1867	—— Lynch		Preternatural birth, Washington street.
May 20, 1867	Clara Corbett	1 year	Asphyxia, from swallowing a screw, 214 Smith street
June 3, 1867	Thos. Hadnett	1 day	" 94 South Sixth street.
June 17, 1867	Christopher Dugan	3 months	" 244 John street.
June 22, 1867	August Hichsehenith	32 years	" from cleaning cesspool, Washington street, Eighteenth Ward.
June 22, 1867	Simon Grosbeck	35 years	Asphyxia, from cleaning cesspool, Washington street, Eighteenth Ward.
June 22, 1867	August Beck	28 years	Asphyxia, from cleaning cesspool, Washington street, Eighteenth Ward.
July 3, 1867	James Farrell	26 days	Asphyxia, Washington avenue.
July 15, 1867	Andrew Smith	1 day	" Pacific street.
July 28, 1867	—— How	6 hours	" 262 Gold street.
August 7, 1867	—— Nolan	1 hour	" 41 DeKalb avenue.
August 18, 1867	—— Darcy		" 21 North Tenth street.
October 16, 1867	Unknown Girl	2 months	Suffocation, 228 First street.
October 21, 1867	Harry C. Parker	5 years	Asphyxia, 8 Putnam avenue.
October 24, 1867	—— Bloodgood	1 day	" 377 Adelphi street.
December 15, 1867	—— Dunn	1 month	" 779 Pacific street,
December 17, 1867	Patrick Lovelv	1 day	" 52 North Seventh street.
February 16, 1868	Mortimer B. White	4 months	Accidental suffocation from bedclothes.
March 2, 1868	Jo n Colby	30 years	Suffocation, by bank of earth.
March 25, 1868	Philip Wilson	2½ months	" overlain, Classon and Greene avenues.
April 9, 1868	Robert Walker	17 years	" by inhaling ammonia or sulphuric acid.
April 7, 1868	Leander Boovery	23 years	" by falling in a vat containing ammonia or sulphuric acid.
May 8, 1868	Geo. W. Ames	4 years	Asphyxia, by coffee bean in throat.
June 3, 1868	William Govenz	1 year	" from bedclothes, Norman avenue.
June 16, 1868	Rose Shields	33 years	Suffocation, by food, piece of meat.
July 6, 1868	Michael Ruck	45 years	Asphyxia, by inhaling foul air from privy vault.
July 9, 1868	Geo. J. Wilson	3 months	Suffocation, bedclothes, 531 Columbia street.

List of Deaths, &c., from January 1, 1848, *to June* 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
July 24, 1868	Jas. Cummisky	5 years	Asphyxia, inhaling foul air in privy vault, 22 Graham avenue
August 21, 1868	Peter Wilson	27 years	Suffocation, in a diving bell at Navy Yard.
August 29, 1868	James Coligan	27 years	Asphyxia, in a diving bell at Navy Yard.
October 31, 1868	James T. French	28 years	Inhaling nitric acid, City Hospital.
December 30, 1868	Daniel Gearey	40 years	Suffocation, in an oil tank, Columbia street.
January 25, 1869	Emma Thorne	2 years	" by smoke, 65 North Fourth street.
January 25, 1669	William Thorne	6 years	" " " "
February 28, 1869	George Lyons	1 year	Accidental suffocation, overlain, Fulton street.
March 4, 1869	Chas. E. Garrison	26 years	Asphyxia, consequent upon idiopathic tetanus.
May 18, 1869	William McDonald	20 days.	Suffocation by bed clothes, 6 Twentieth street.
September 6, 1869.	David Sixton	35 years	Asphyxia, falling wall, 116 First street.
September 15, 1869	James Breslin	35 years	" foot of South Tenth street.
*October 7, 1869	Frederick Clark	16 years	Accidental suffocation from gas, Myrtle avenue.
February 4, 1870	Lillie Green	4 months	Suffocation, from bedclothes, Underhill street and Warren avenue.
February 6, 1870	Martin Kinney	45 years	Strangulation, while vomiting when intoxicated, 26 Third avenue.
February 13, 1870	Egbert E. Young	15 years	Strangulation, caused by convulsions, causing him to fall in some gasoline, 443 Myrtle avenue
February 24, 1870	John McCarron	26 years	Suffocation, by coal gas from stove, 38 Bridge street.
February 26, 1870	James McGlyn	1 year	Suffocation, by bedclothes, 26 Meeker avenue.
April 5, 1870	Thomas Egan	...	" overlain, Butler and Bond streets.
April 23, 1870	James Henderson	1 day	Asphyxia, 319 Hicks street.
May 29, 1870	Edward Doherty	38 years	Suffocation, Jay and Water streets.
May 31, 1870	Frank T. Vail	5 years	Bank of earth, Franklin avenue.
June 4, 1870	William Muller	32 years	" " DeKalb avenue.
June 5, 1870	Mary E. Laffin	2 hours	Asphyxia, 5 Mill street.
June 8, 1870	Herman Ruelhausen	1 day	" Third and South Tenth streets.
June 19, 1870	James G. McCullagh	3 months	Suffocation, by bedclothes, 254 Atlantic avenue.

List of Deaths, &c., from January 1, 1848, *to June* 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
June 23, 1870	Otto Mills	6 years	Bank of earth, Carroll street and Third avenue.
June 23, 1870	Frederick Barnhart	6 years	" " "
April 23, 1870	James Mack	3 years	" " "
August 21, 1870	Emily Bulkley	64 years	Asphyxia, suicide by hanging, 303 South Fourth street.
August 28, 1870	Elsie Beucheir.	$1\frac{1}{2}$ years	Suffocation, 95 Johnson avenue.
September 21, 1870	Samuel Toner	17 years	Smothered by feed stuff, Van Brunt street.
September 25, 1870	John McDermott	49 years	Suffocated in hold of a vessel, Jackson avenue.
October 23, 1870	Nicholas McGrath	5 years	" by earth bank Van Buren street.
November 8, 1870	Conrad Klug	1 day	" 227 Johnson avenue.
February 8, 1871	——— Weekes		Asphyxia, 50 Carroll street.
March 21, 1871	Elizabeth A. Moore	4 years	" 14 Clermont street.
April 2, 1871	Caroline Holliday	5 years	Suffocation by food, piece of meat, 29 Varet street
April 14, 1871	eter Kehoe	1 day.	Asphyxia, 111 North Fifth street.
April 15, 1871	Chas. Wood	8 months.	" 287 Smith Street.
April 18, 1871	Zela Ohlhaupt	6 months	Suffocation, 75 Stagg street.
April 22, 1871	Owen Ward	4 months	Bed clothes, 114 Front street.
August 29, 1871	Margaret A. Forsyth	33 years	Effects of intemperance, 58 Summit street.
October 9, 1871	Catharine Boyle	27 years	Suffocation during convulsion, 116 Smith street.
October 21, 1871	Patrick McManus	24 years	" by grain 30 Atlantic avenue.
October 27, 1871	Luella Voorhis	2 months	" by its mother, 154 Seventeenth street.
November 22, 1871	Mary Mehleig	2 hours	" 61 Ewen street.
November 23, 1871	James Shea	1 month	" overlain, 120 Dikeman street.
November 29, 1871	Mary McGibney	40 years	Bed clothes, intemperance, 30 Main street.
December 12, 1871	Edward Hewitt	2 months	Accidental suffocation by bed clothes, Smith street
December 25, 1871	Thomas Aberneathy	2 months	" " by bronchitis, 468 Baltic street.
February 29, 1872	Thomas Madden	38 years	Bank of earth, 154 Twentieth street.
March 11, 1872	Elizabeth Schaffo	4 months	Bed clothes, 21 Bridge street.
April 1, 1872	Mary J. Norton	59 years	Coal gas from defective furnace, 196 Raymond street
June 14, 1872	Minnie Hatson	1 day	Asphyxia, 83 Fourth avenue.

List of Deaths, &c., from January 1, 1848, *to June* 1, 1883.—Continued.

DATE.	NAME.	AGE.	CAUSE OF DEATH AND LOCATION.
July 6, 1872	Nora Pearce	1 month	Bedclothes, Caroll and Johnson streets.
October 16, 1872	——— Snyder	1 month	" 185 West Baltic street.
December 10, 1872	John Lynch	16 years	Privy vault, 344 North Sixth street.
December 24, 1872	Ida Hanna	2 months	Overlain, 78 Ainslie street.
December 28, 1872	James Pursell	64 years	Piece of meat, 373 Kent avenue.
April 1, 1873	Mary Webster	11 months	Accidental suffocation from bedclothes, 394 Clinton avenue.
January 25, 1873	Michael Casey	40 years	Bank of earth, Eighteenth street and Tenth avenue
January 25, 1873	Catherine Muir	20 days	Asphyxia from bedclothes, 249 State street.
January 28, 1873	Wm. Conley	65 years	Grain, Irving street.
March 31, 1873	James M. Montgomery	11 years	Accidental strangulation, 295 Ryerson street.
April 24, 1873	Mary J. McLoughlin	3 months	Overlain, 179 Sackett street.
May 6, 1873	William Babin	8 months	From bedclothes, 140 Franklin.
June 13, 1873	Unknown Child	...	Asphyxia, Third Precinct Police.
December 2, 1873	Anna Stralman	14 days	Suffocation, 817 Park avenue.
January 24, 1874	Terence Slavin	56 years	" 35 South Third street.
October 16, 1874	Thomas Owens	16 days	Overlain, Hamilton avenue.
January 19, 1875	Patrick McCormick	44 years	Smoke, 336 Pacific street.
January 19, 1875	Timothy McCormick	74 years	" "
January 30, 1875	Alfred Wilson	8 days	Strangulation, by feeding from a bottle, 339 Grand
April 8, 1875	Mary W. Burke	10 months	Suffocation by bedclothes, 174 Gold street.
April 24, 1875	Ann Brady	4 months	Suffocation, overlain, 414 Smith street.
May 4, 1875	Peter Megany	39 years	Bank of earth, Eleventh avenue and Seventeenth street.
May 4, 1875	Michael Reily	22 years	Bank of earth, Eleventh avenue and Seventeenth street.
May 8, 1875	Charles Brown	3 months	Asphyxia from bedclothes, 287 Grand street.
May 13, 1875	Mary Kephart	3 days	Premature birth, 60 Gerry street.
May 29, 1875	Theodore Geibert	1½ years	Asphyxia in a privy, 10 Bergen street.
June 10, 1875	Geo. Stander	43 years	Suffocation in a vinegar factory, 138 Twenty-second street

List of Deaths, &c., from January 1, 1848, *to June* 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
June 10, 1875	Chas. Bufries or Vofries	42 years	Suffocation in a vinegar factory, 138 Twenty-second street.
August 1, 1875	Mary Jones	7 months	Suffocation, 162 Hope street.
August 15, 1875	Catharine Muller	29 days	Asphyxia by bedclothes, 209 Meserole street.
August 23, 1875	Frederick Burger	15 days	" 172 Harrison avenue.
September 24, 1875	James Sheridan	1 day	" at birth, 225 Sixteenth street.
September 27, 1875	Anthony Orna	7 months	" by bedclothes, 258 Hamilton avenue.
November 14, 1875	Unknown Child	1 month	Umbilical hemorrhage, 297 Fourth street.
November 24, 1875	Louis Wygand	1 year	Food, piece of sausage, 190 Meserole street.
November 26, 1875	Thomas Dowd	6 years	Bank of earth, 403 Third street.
November 26, 1875	Francis McGinerty	7 years	" "
November 27, 1875	Joseph M. Hallich	10 years	" 404 Third street.
December 8, 1875	Kate Keller	1 month	Asphyxia, 9 Grattan.
March 3, 1876	Barbara Peterman	35 years	" during pregnancy, 117 Hopkins street.
March 7, 1876	James Ryan	76 years	" Bushwick avenue and Chestnut street.
March 7, 1876	Michael Rielly	93 years	" "
March 7, 1876	Nicholas Pfeifer	70 years	" "
March 7, 1876	Jas. Maron	73 years	" "
March 7, 1876	Conrad Sanderson or Linderman	87 years	" "
March 7, 1876	Peter Kelly	75 years	" "
March 7, 1876	Patrick Healy	72 years	" "
March 7, 1876	Daniel Gorman	76 years	" "
March 7, 1876	Edward Farrell	71 years	" "
March 7, 1876	Herman Englehart	72 years	" "
March 7, 1876	Geo. Donnelly	69 years	" "
March 7, 1876	John Cavanagh	72 years	" "
March 7, 1876	James Connolly	71 years	" "
March 7, 1876	John Conroy	68 years	" "
March 7, 1876	Theodore Chaggert	75 years	" "
March 7, 1876	Mathew Brennan	68 years	" "
March 7, 1876	John Bardow	66 years	" "

List of Deaths, &c., from January 1, 1848, *to June* 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
March 20, 1876	Child ——Madden	½ hour	Asphyxia, from caul, 366 Carroll street.
March 20, 1876	Mary E. Tierney	5 months	" from bedclothes, 220 North Eighth street
May 14, 1876	James Fox	½ hour	" 250 North Sixth street.
May 26, 1876	Francis Fitzpatrick	3 months	" bedclothes, 683 Fifth avenue.
September 8, 1876	Theresia Riley	1 year	Swallowing a piece of ivory, 230 Throop avenue.
September 19, 1876	Catharine Ganley	1 month	Overlain, 926 Warren street.
September 26, 1876	Catharine Hueston	5 months	Smoke, 1071 St. Marks avenue.
October 8, 1876	William M. Palmer	2 years	Suffocation, swallowing a needle case, 226 Duffield street.
November 3, 1876	John R. Hume	29 years	Suffocation, fall in epilepsy, 171 Lee avenue.
November 10, 1876	Henry Smith	1 day	Suffocation by bedclothes, 392 State street.
November 30, 1876	Joseph McDevitt	1 month	Asphyxia from neglect, 64 Franklin avenue.
December 15, 1876	Chas. Schmitzer	33 years	Smoke, 199 Scholes street.
December 21, 1876	Catharine Fraynor	8 months	Asphyxia, 120 John street.
December 23, 1876	John Moran	45 years	Earth, 172 Huntington street.
December 25, 1876	Lillie Henrich	4 months	Asphyxia, 98 Walton street.
January 4, 1877	Child of Lena Weir		Privy, Van Brunt street.
February 2, 1877	Henry Northcote	3 years	Suffocation by bean, 297 Baltic street.
February 26, 1877	Loretta Mills	2 months	Asphyxia, 81 Spencer street.
March 19 1877	Catherine Dervin	6 months	Overlain, 26 High street.
March 30, 1877	William Lerris	52 years	Earth, South Sixth and First streets.
April 1, 1877	Margaret Daily	45 years	Asphyxia, 223 North Fifth street.
September 13, 1877	Florence Sullivan	70 years	Suffocation in mud, Dwight street.
October 17, 1877	Mary Foster	3 days	Asphyxia, 41 Elm street.
November 5, 1877	William Kelly	42 days	Earth, Ralph avenue.
November 5, 1877	Catharine Nillie	19 years	Smoke, 721 Gates avenue.
November 5, 1877	Jacob Nillie	1 year	" " "
March 8, 1878	John Millenbecher	44 years	Fell in a charcoal tank at sugar house, foot South Second street.
March 25, 1878	John Connolly	1 year	Smoke, Van Brunt street.
April 3, 1878	Thomas Murray	4 years	Bank of earth, Bergen and Franklin avenue.

List of *Deaths, &c., from January* 1, 1848, *to June* 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
*June 24, 1878	Oliver S. Vincent	35 years	Municipal Department Building, explosion of gas.
September 3, 1878	Ledger Hands	2 months	Overlain, 466 Sackett street.
October 6, 1878	John Wiedeman	18 hours	Accidental suffocation from bedclothes, 633 Atlantic avenue.
November 6, 1878	Thomas Doxie	30 years	Grain, foot of Pacific street.
December 23, 1878	Geo. Walters	16 years	" Wallabout Basin
January 6, 1879	Elizabeth Peterson	8 months	Bedclothes, 526 Hicks street.
February 3, 1879	Chas. T. Cameron	5 days	Overlain, 1742 Fulton street.
July 6, 1879	Rosetta Lippman	98 years	Food, 1012½ Lafayette avenue.
August 14, 1879	Chas. Thinnes	1 month	Bedclothes, 187 Dupont street.
September 11, 1879	Patrick O'Connors	35 years	Grain, Robinsons stores.
October 2, 1879	Frank Eckerman	5 months	Bedclothes, 145 Prince street.
November 9, 1879	Mary Miller	33 years	Suffocation, in a cistern, Flushing and Wyckoff avenues
April 12, 1880	Thomas Murphy	6 months	Bedclothes, 52 North Third street.
June 17, 1880	Lillian McAuley	4 months	Accidental Suffocation, 51 Garnet street.
May 3, 1880	Eugene J. Reardon	3 months	" " 379 Court street.
June 26, 1880	Patrick J. Lee	1 month	Overlain, 464 Columbia street.
July 20, 1880	Adelia A. Thompson	1 month	Suffocation, 12 North Portland street.
August 9, 1880	Kittie Schellus	1 month	Overlain, 240 Ellery place.
August 15, 1880	John Murphy	8 months	Accidental suffocation, 14 Wythe avenue.
August 28, 1880	John Mooney	36 years	Grain, foot Sedgwick street.
August 30, 1880	Elizabeth Gallagher	1 month	Bedclothes, 43 Taylor street.
October 29, 1880	John Dickinson	35 years	Inhaling vapors of mercury, 25½ Moffat street.
November 7, 1880	Andrew Frick	....	Privy vault, 300 Ellery place.
November 20, 1880	Sebastian Studder	89 years	Food, 40 Bartlett street.
February 16, 1881	Unknown Child	15 minutes	Privy, Flushing and Clermont avenues.
February 27, 1881	Frederick Hudson	7 months	Bedclothes, 76 Fleet place.
April 14, 1881	Catharine O'Toole	5 minutes	Asphyxia, 27 Main street.
*April 16, 1881	Matilda A. Hogfeldt	24 years	Water gas, 296 Sackett street.
April 25, 1881	Conrad Bechtel	4 months	Suffocation by sponge, 71 North First street.

List of Deaths, &c., from January 1, 1848, to June 1, 1883.—Continued.

Date.	Name.	Age.	Cause of Death and Location.
May 12, 1881	Francis Callahan	33 years	Bank of earth, Kingsland avenue.
May 6, 1881	Elizabeth Frederick	4 months	Suffocation, 511 Kent avenue.
May 24, 1881	—— Towner	5 minutes	Asphyxia, 55 State street.
June 8, 1881	Peter Murphy	6 months	Overlain, 6 State street.
June 9, 1881	Francis F. Jones	24 years	Asphyxia from epilepsy, 146 Broadway.
June 15, 1881	Patrick Morrison	38 years	Smoke, Pierrepont stores.
June 22, 1881	Daniel Christopher	9 months	Bedclothes, 78 North Third street.
June 24, 1881	—— Santila	5 minutes	Asphyxia, 65 Adams street.
*July 9, 1881	Patrick Cook	57 years	Fall and water gas, Nevins and Degraw streets.
July 20, 1881	Geo Snyder	11 months	Anæsthetics, 422 Lewis avenue.
August 1, 1881	Annie Byrne	29 years	Asphyxia, homicide 134 North Fourth street.
August 31, 1881	Mary E. Lawler	1½ years	Privy, 66 North Eighth street.
September 19, 1881	Henry D. Leach	2 months	Bedclothes, 190 Kent street.
October 26, 1881	Geo. Mills	31 years	Food, 51 McKibben street.
*October 13, 1881	Robert Agins	22 years	Water gas, Long Island College Hospital.
October 28, 1881	Jacob H. Wendebergh	2 months	Suffocation, 208 Sandford street.
December 22, 1881	Nettie Cronenbert	10 months	Suffocated by thimble, 1166 Myrtle avenue.
December 26, 1881	Margaret Egnan	4 months	Bed clothes, 109 North Second street.
*January 25, 1882	Susanna W. Wallace	61 years	Coal gas, 362 Pearl street.
*January 27, 1882	Thomas Wallace	71 years	" " "
January 27, 1882	—— Eliason	½ hour	Asphyxia, 447 Warren stree.
February 1, 1882	Ralph Turner	2 years	Food, 156 Powers street.
February 4, 1882	Lindsay Baird	50 years	Lime kiln, North Tenth and Fifth streets.
February 17, 1882	Levi J. Stevens	38 years	Asphyxia, explosion, Jewels Mills.
March 17, 1882	James Carroll	17 days	Bedclothes, 399 Seventeenth street.
April 4, 1882	John F. E Grady	22 years	Food, 134 Eighth street.
April 25, 1882	Stephen Currie	48 years	Smoke, 102 Henry street.
May 26, 1882	Kate A. Blake	2 months	Suffocation, 771 Herkimer street.
June 17, 1882	Unknown Child	12 hours	" South Fourth street.
August 9, 1882	Mary Nolan	2 months	Overlain, 87 Wolcott street.
*October 10, 1882	Theodore Hartke	23 years	Water gas, 14 Fulton street.

Causes of Suffocation as far as could be Ascertained.	No Age Stated.	Under One Year.	One Year.	Two Years.	Three Years.	Four Years.	Total Under Five Years.	Five Years.	5 to 10 Years.	10 to 15 Years.	15 to 20 Years.	20 to 25 Years.	25 to 30 Years.	30 to 35 Years.	35 to 40 Years.	40 to 45 Years.	45 to 50 Years.	50 to 55 Years.	55 to 60 Years.	60 to 65 Years.	65 to 70 Years.	70 to 75 Years.	75 to 80 Years.	80 to 85 Years.	85 to 90 Years.	90 to 95 Years.	Total.
*Asphyxia and suffocation (cause not stated)	70	145	8	8	6	6	243	12	6	2	1	6	3	4	3	6	3	2	1				1				293
†Suffocation by smoke		2	2	3		1	8	2		1	1	1	1	1	1	1				4	8	4		1	1		35
Suffocation by bedclothes		33	2				35																				35
" bank of earth					1	1	2	6	1		1	1	4	4	2	1	3										25
" overlaying	1	19	1				21																				21
" at birth	8	6					14																				14
*Accidental suffocation (cause not stated)	4	6					10												1								11
Suffocation by illuminating gas										2	3	1						1	1		2	1					11
" carbonic acid gas in a distillery vat													1														1
" noxious gas		1					1																				1
" coal gas from stove												1						1									2
" irrespirable gas									1																		1
Explosion of illuminating gas														1													1
Suffocation by food		1	1	1			3	1			1		2				1			1				1		1	11
" by grain										2	1		2	2						1							8
" in privy vaults	2	1	2				5	1		1						1											8
Strangulation	4						4		1				1			1											7
Suffocation by charcoal										1		1		2	1												5
" by nitric acid												1					1		1								3
" by bean in the throat		1			1	1	3																				3
" in a washtub		2	1				3																				3
" while cleaning a cesspool												1	1	1													3
" in lime kiln																1	1										2
" by sulphuric acid										1	1																2
" by falling wall														2													2
" in vinegar factory															2												2
" in coal bin													1		1												2
" in a cistern										1			1														2
" by abscess of throat		1	1				2																				2
" in a diving bell at United States Navy Yard												2															2
" while intoxicated													1		1												2
Homicide by strangulation		1					1					1															2
Suffocation by foreign body in throat									1																		1
" by inhaling lead			1				1																				1
" by idiopathic tetanus												1															1
" during convulsions										1																	1
" swallowing a piece of ivory			1				1																				1
" in mud																					1						1
" by inhaling vapors of mercury														1													1
" by piece of sponge		1					1																				1
" by anæsthetics		1					1																				1
" by swallowing thimble		1					1																				1
Asphyxia and explosion														1													1
Suffocation by swallowing a screw			1				1																				1
" while cleaning an oil tank															1												1
" from vomiting																1											1
" in hold of a vessel																1											1
" by swallowing needle case				1			1																				1
Total	89	222	21	13	8	9	362	22	10	12	9	17	18	19	12	13	9	4	4	6	11	5	1	2	1	1	538

* From developments during this search it is assumed that the greater part of these, no age and under one, were still-born or preternatural births.

† Not including the 284 victims of the Brooklyn Theatre fire, December 5, 1876.

List of Deaths, &c., from January 1, 1848, *to June* 1, 1883.—Concluded.

Date.	Name.	Age.	Cause of Death and Location.
*October 10, 1882	William Hueske	26 years	Water Gas, 14 Fulton street.
*October 29, 1882	Susan E. Fendick	19 years	Water gas, 111 Fort Green Place.
November 18, 1882	John Twomey	37 years	Bank of earth, Howard avenue and Jefferson.
November 16, 1882	Joseph Brennan	54 years	Food, Jay and Willoughby.
January 7, 1883	Chas. Coutten	4 days	Overlain, Maternity.
March 8, 1883	William Hill	45 years	Lime kiln, North Tenth and Fifth streets.
March 9, 1883	James Cody	30 years	Coal bin, Foot Baltic street.
March 9, 1883	Michael Cody	40 years	"
*March 15, 1883	Hannah C. Johnson	79 years	Water gas, 215 Graham street.
April 16, 1883	John Hughes	50 years	Bank of earth, Manhattan avenue.
*May 9, 1883	John A. Hanf	77 years	Water Gas, 128 Rutledge street.

*The cases that are marked with the asterisk are the only deaths chargeable to illuminating gas, in this city, that have been developed by this investigation.

APPENDIX B. PAPER 2.

WILLIAMSBURGH GAS WORKS,
Foot of North Twelfth Street,
BROOKLYN, N. Y., April 21, 1883.

Your letter to our late president is sent to me to answer. In reply I would state that I have never known of a death from illuminating coal gas. There has certainly not been any deaths in the district supplied by this Company, of which I have ever heard, and which I have been managing for over twenty-nine years.

The only deaths from illuminating gas in this city of which there is any record, are as follow:

Matilda Hogfeldt, April 15, 1881.
Patrick Cook, July 11, 1881.
John Agins, October 13, 1881.
W. King, May 13, 1882.
William Hueske, October 9, 1882.
Theodore Hartke, October 9, 1882.
Susan Fendick, October 28, 1882.
Hannah C. Johnson, March 14, 1883.

In all of the above cases it was where water gas was in nse, as far as I have been able to learn, and it has never been proved to the contrary, that I am aware of.

Yours respectfully,

JOS. R. THOMAS,
Engineer Williamsburgh Gaslight Co.

APPENDIX B. PAPER 3.

THE BROOKLYN GASLIGHT COMPANY,
180 Remsen Street,
BROOKLYN, N. Y., May 2, 1883.

Yours of the 17th ult. received. Enclosed please find the information requested; if there is any further information required we will cheerfully give it, if possible.

Yours respectfully,

E. STORER,
Secretary.

The following ghastly record of fatal and serious accidents resulting from the inhalation of illuminating water gas in New York city and the city of Brooklyn, from 1878 to 1882, tells its own story:

NEW YORK.

John Gilleland, St. Charles Hotel, Oct. 27, 1878, suffocated.
John Brown, 31 Bowery, Nov. 8, 1878, dead.
Lorenza M. Locoma, 21 East 4th street, Nov. 18, 1878, dead.
Dominick Hart, 133 Crosby street, Dec. 20, 1878, suffocated.
Elizabeth Williams, 31 Bowery, Nov. 8, suffocated.
Wm. Rigby, 133 Crosby street, Dec. 20, suffocated.
Thos. Knight, 133 Crosby street, Dec. 20. suffocated.
Jerry Nichols, St. Cloud Hotel, April, 25, dead.
Susan Cochrane, 53 West 13th street, Jan. 23, 1880, dead.
Mr. Augsley, New York Hotel, April 16, 1880, suffocated.
Mr. Broodhurst, New York Hotel, April 16, 1880, suffocated.
John Donovan, 115 West 32d street, May 23, 1880, dead.
Andrew Mackey, 49 Whitehall street, May 18, 1880, suffocated.
Lewis Baker, French's Hotel, May 21, 1880, dead.
S. Lawson, New Southern Hotel, June 4, 1880, dead.
Augustus Hagenor, 45 Bowery, June 25, 1880, suffocated.
J. Glospsky, Crook's Hotel, Sept. 20, 1880, dead.
David Kearney, 316 Greenwich street, Oct. 2, 1881, suffocated.
G. J. Maxwell, 316 Greenwich street, Oct. 2, 1881, suffocated.
Sophia Tugenito, Anson House, Nov. 1, 1880, dead.
Bertha Wiese, 338 Henry street, Nov. 4, 1880, dead.
Thomas Coleman, Putnam, Dec. 3, 1880, dead.
Patrick Ferrigan, 80 Duane streeet, Dec. 1, 1880, dead.
John Sloane, 80 Duane street, Dec. 1, 1880, suffocated.
S. Sherwood, Earle's Hotel, Dec. 16, 1880, dead.
F. Borge, Summit Hotel, Nov. 19, 1880, dead.
C. W. Davis, Sweet's Hotel, Dec. 17, 1880, suffocated.
R. A. Stillwell, North River Hotel, Dec. 24, 1880, dead.
Frederick Albert, Summit Hotel, Dec. 27, 1880, suffocated.
Patrick Nolan, 10 First street, Jan. 1, 1881, dead.
I. Hammersley, 10 First street, Jan. 1, 1881, dead.
R. B. Reynolds, Van Dyke House, Jan. 3, 1881, dead.
Frederick Keal, 39 Bowery, Jan. 6, 1881, suffocated.
Joseph A. Grant, 1355 Broadway, Jan. 12, 1881, suffocated.
Michael Lynch, 328 East 27th street, Jan. 14, 1881, suffocated.
John Bunyan, New York Hotel, Jan. 22, 1881, dead.
John Galen, Central Hotel, Jan. 24, 1881, suffocated.
———Knapp, Central Hotel, Jan. 24, 1881, suffocated.
Henrietta Braundofer, 955 3d avenue, Feb. 12, 1881, dead.
Barbara Weiss, 955 3d avenue, Feb. 12, 1881, dead.
Gustave Bertline, 310 Broome street, April 3, 1881, dead.
Andrew O'Donnell, Summit Hotel, April 8, 1881, dead
Sophia Vensere, 200 West 56th street, April 8, 1881, dead.

Frank Watson, Van Dyke House, May 9, 1881, suffocated.
John McCarty, Grand Union Hotel, Sept. 29, 1881, suffocated.
Rev. Abijah Green, Hamilton House, Oct. 21, 1881, dead.
Joseph Caille, 405 6th avenue, Nov. 11, 1881, dead.
Wm. Zimmerman, Municipal Gas Works, Oct. 16, 1881, dead.
Michael Coyne, St. Vincent Hotel, Jan. 27, 1881, dead.
Thomas J. Durand, Occidental Hotel, Feb. 16, 1882, dead.
Richard H. Stryker, Bridge Hotel, March 1, 1882, dead.
F. W. Hoffman, North River Hotel, March 2, 1882, dead.
Emil Acoreie, steamer Providence, May 5, 1882, suffocated.
Lily J. Brandt, steamer Providence, May 5, 1882, dead.
James H. Langley, Newport steamer, May 31, 1882, dead.
Lydia Coleman, 106 E. 14th street, May 31, 1882, suffocated.
Daughter of the above, 106 E. 14th street, May 31, 1882, suffocated.
Elliot Lavina, 176 Washington street, May 18, 1882, suffocated.
Wm. Meakin, Eagle Hotel, June 2, 1882, dead.
Mrs. Meakin, Eagle Hotel, June 2, 1882, dead.
H. R. Covert, French's Hotel, June 2, 1882, dead.
Wm. Thomas, Van Dyke House, June 27, 1882, dead.
E. D. Miller, Cosmopolitan Hotel, July 7, 1882, suffocated.
Franz Stark, Castle Garden Hotel, July 7, 1882, suffocated.
M. Hartman, Broadway Hotel, Aug. 21, 1882, suffocated,
Georavini Romanolle, 70 James street, Aug. 13, 1882, suffocated.
Angelo Lammino, 70 James street, Aug. 13, 1882, suffocated.
Henry Conklin, 108 South street, Sept. 20, 1882, suffocated.
Jennie E. Walcott, 14 West 28th street, Oct. 26, 1882, dead.
Emma Straus, Glen Island Hotel, Oct. 7, 1882, dead.
Timothy Kelly, 2297 4th avenue, Oct. 27, 1882, dead.
Daniel Leary, 1 Chamber street, Nov. 18, 1882, dead.
H. Robert Petri, 65 Bowery, Nov. 19, 1882, dead.
James Walker, Occidental Hotel, Nov. 22, 1882, dead.
Annie Stademeyer, 47 Bowery, Nov. 30, 1882, dead.
Honora Mahoney, 4 Attorney street, Dec. 15, 1882.
Andrew J. Culver, 112 West street, Jan. 10, 1883.
Arthur Schofield, Hotel St. Stephens, Jan. 20, 1883.
J. Lawrence, Putnam House, March, 1, 1883.
Wm. Mulcahey, N. Y. and Brooklyn Bridge Hotel, March 25, 1883.

BROOKLYN.

Matilda Hogfeldt, 296 Sackett street, April 15, 1881, dead.
Patrick Cook, Fulton Mun. Gas Works, July 11, 1881, dead.
John Agins, Clinton House, Oct. 13, 1881, dead.
W. King, of West Randolph, Vt., Clinton House, May 13, 1882, suffocated.

Wm. Hueske, Annex Hotel, 12 Fulton street, Oct. 9, 1882, dead.
Theodore Hartke, Annex Hotel, 12 Fulton street, Oct. 9, 1882, dead.
Susan Fendick, 111 Green Place, Oct 28, 1882, dead.
Mrs. Hannah C. Johnson, 215 Graham street, March 15, 1883.

APPENDIX B. PAPER 4.

[False Reports of Death by the Inhalation of Illuminating Gas.]

April, 1881. John Smith, committed suicide. This is the case referred to on page 4 of the pamphlet.

November, 1881. Korokoff is the name of a man who tried to commit suicide. It was about six hours before he was found. Recovered consciousness before he was removed to the New York Hospital. Employed by the Triumph Truss Co. at the time and afterwards. Was fully recovered and out in two or three days.

NOTE.—Before taken from the building was so far recovered that it took three policemen to manage him.

October, 1880. William Drummond. Case of whiskey, not gas. The man was taken to Bellevue Hospital, supposed to be overcome by gas, but came to from a drunken stupor next morning all right. No gas in his room. These facts ascertained on personal investigation the following day.

February, 1882. 226 East Eleventh street. Man employed at A. T. Stewart's old store boarded at this place. Came home rather full and found some hours afterward in his room with gas turned on, and unconscious (either from gas or whiskey); he came to, however, shortly after being found, and was as well as ever next day.

November, 1882. Astor Place Hotel not burning coal gas since 1872. Either Mutual or Municipal.

Extract from a statement by the Gaslight Co.

APPENDIX B. PAPER 5.

[Record of deaths from illuminating gas from 1866 to 1883 inclusive, to date, and number of inquests held each year. Received from coroner's office, New York City.]

1866. Number of inquests, 2,505. Deaths from illuminating gas. None recorded by verdict; look at Nos. 281 and 400 of the 4th quarter, which are cases of asphyxia from cause not given in verdict.

1867. Number of inquests, 2,170. Deaths from illuminating gas, 3.

Inquest No. 150—4th quarter. Abat, Leonce, 50 years, 10 Waverly place, October 27.

Inquest No. 293—4th quarter. O'Connor, Maria, 15 years, 83d street, between 3d and 4th avenues, November 30.

Inquest No. 402—4th quarter. Gantz, John F., 59 years, Bloomingdale and Inwood lane, December 16.

Look at inquests 415 to 420, 4th quarter, caused by fire.

1868. Number of inquests, 2,480. Deaths from illuminating gas, 2.

Inquest No. 8—1st quarter. McArdle, James, 34 years, choked by a piece of meat, 99 Cannon street, January 1.

Inquest No. 98—2d quarter. Rhode, Mary, 37 years, 112 Cedar street, April 13.

1869. Number of inquests, 2,548. Deaths from illuminating gas, 1.

Inquest No. 307—4th quarter. English, David, 47 years, U. S. Hotel, November 5.

1870. Number of inquests, 2,978. Deaths from illuminating gas, 1.

Inquest No. 418—2d quarter. Howlen, Frank, 4½ years, 104 Eighth avenue, May 26.

1871. Number of inquests, 3,114. Deaths from illuminating gas, 7.

Inquest No. 221—1st quarter. Laughlin, John, 27 years, 1497 Third avenue, January 31.

Inquest No. 222—1st quarter. Laughlin, Bernard, 3 years, 1497 Third avenue, January 31.

Inquest No. 223—1st quarter. Sands, Susan, 25 years, 1497 Third avenue, January 31.

Inquest No. 224—1st quarter. Laughlin, Ann, 30 years, 1497 Third avenue, January 31.

Inquest No. 697—1st quarter. Stewart, Donald, 40 years, Putnam House, March 29.

Inquest No. 80—2d quarter. Newman ———, 25 years, New England Hotel, April 9.

Inquest No. 407—2d quarter. Cronkite, Jane Ann, 16 years, 111 West 26th street, May 19.

1872. Number of inquests, 3,625. Deaths from illuminating gas, 3.

Inquest No. 51—1st quarter. Ash, Rose, 35 years, by a tumor, 44 Allen street, January 4.

Inquest No. 523--1st quarter. Gerhardt, Henry A., 44 years, 22 First street, February 28.

Inquest No. 584—2d quarter. Mullooly, John, 10 years, caries of cervical vertebra, 411 East 29th street, May 25.

1873. Number of inquests, 2,859. Deaths from illuminating gas, 1.

Inquest No. 490—4th quarter. Healy, Sophia, 55 years, 86th street between 1st and 2d avenues, December 6.

1874. Number of inquests, 2,914. Deaths from illuminating gas, 1.

Inquest No. 344—2d quarter. Miller, Alexander, 50 years, 51 East 10th street, May 11.

1875. Number of inquests, 3,363. Deaths from illuminating gas, none.

1876. Number of inquests, 3,151. Deaths from illuminating gas, 1.

Inquest No. 462—1st quarter. Warner, Dora, 43 years, affection of the glottis, 275 Second street, February 29.

1877. Number of inquests, 2,846. Deaths from illuminating gas, none.

1878. Number of inquests, 3,130. Deaths from illuminating gas, 2.

Inquest No. 339—4th quarter. Brown, John, 30 years, 31 Bowery, November 7.

Inquest No. 418—4th quarter. Lacoma, Lorenzo M., 17 years, 21 East 4th street, November 16.

1879. Number of inquests, 3,138. Deaths from illuminating gas, 2.

Inquest No. 61—first quarter. Schroeder, Jenny, 6 years, 331 East 15th street, January 6.

Inquest No. 135—2d quarter. Nichols, Leroy F., 36 years, St. Cloud Hotel, April 1.

1880. Number of inquests, 3,762. Deaths from illuminating gas, 11.

Inquest No. 169—1st quarter. McGurk, Sarah, 20 years, N. Y. Hospital, January 21.

Inquest No. 504—2d quarter. Baker, Lewis, 65 years, French's Hotel, May 20.

Inquest No. 305—2d quarter. Donovan, John, 45 years, 115 West 22d street, May 1.

Inquest No. 671—2d quarter. Lanson, Adam S., 53 years, 713 Broadway, June 3.

Inquest No. 853—3d quarter. Elofsky, Jacob, 52 years, Crook's Hotel, 84 Chatham street, September 19.

Inquest No. 293—4th quarter. Ingenito, Sophia, 21 years, Anson House, 79 Spring street, October 31.
Inquest No. 330—4th quarter. Blumerneis, Bertha, 17 years, 233 Henry street, November 4.
Inquest No. 482—4th quarter. Seebo, John, 19 years, Summit Hotel (Bowery), November 18.
Inquest No. 632—4th quarter. Coleman, Thomas, 44 years, Putnam House, December 3.
Inquest No. 787—4th quarter. Sherwood, Samuel, 25 years, Earle's Hotel, December 16.
Inquest No. 873—Stilwell, Albert A., 37 years, North River Hotel, December 24.

1881. Number of inquests, 3,994. Deaths from illuminating gas, 15.
Inquest No. 1—1st quarter. Nolan, Thomas, 35 years, 10 First street, January 1.
Inquest No. 52—1st quarter. Reynolds, Rensler P., 22 years, 28 Bowery, January 3.
Inquest No. 178—1st quarter. Lynch, Michael, 31 years, 332 East 27th street, January 14.
Inquest No. 467—1st quarter. Weis, Barbara, 19 years, 955 Third avenue, February 12.
Inquest No. 468—1st quarter. Braundorfer, Henrietta, 16 years, 955 Third avenue, February 12.
Inquest No. 27—2d quarter. Bortlein Gustav, 30 years, 310 Broome street, April 3.
Inquest No. 118—2d quarter. Schmidt, Daniel, 28 years 395 Bowery, April 10.
Inquest No. 271—2d quarter. Svenson, Sophie, 28 years, 200 West 56th street, April 25.
Inquest No. 371—3d quarter. Mannot, J. V., 50 years, 6 West 11th street, July 29.
Inquest No. 440—3d quarter. Ottersen, Louis, 43 years, 318 Fourth avenue, August 6.
Inquest No. 485—3d quarter. Osborne, J. B., 27 years, 14th street and Second avenue, August 6.
Inquest No. 212—4th quarter. Green, Abijah, 75 years, 300 West 125th street, October 20.
Inquest No. 399—4th quarter. Caille, Joseph, 40 years, 405 Sixth avenue, November 8.
Inquest No. 598—4th quarter. Reid, James, 56 years, Bellevue Hospital, November 22.
Inquest No. 806—4th quarter. Zimmerman, Wm., 30 years, foot West 46th street, December 13.

1882. Number of inquests, 4,067. Deaths from illuminating gas, 19.

Inquest No. 301—1st quarter. Coyle, Michael, 48 years, 28 Bowery, January 25.

Inquest No. 538—1st quarter. Durand, Thos. J., 54 years, Occidental Hotel, cor. Bowery and Broome, February 16.

Inquest No. 674—1st quarter. Stryker, Johnson H., 38 years, 48 Chatham street, March 1.

Inquest No. 681—1st quarter. Hoffman, Fred. W., 23 years, 109 Barclay street, March 2.

Inquest No. 713—1st quarter. Ker, Ellen, 78 years, 245 West 11th street, March 4.

Inquest No. 736—2d quarter. Covert, Philetus R., 51 years, French's Hotel, June 1.

Inquest No. 744—2d quarter. Meekim, William, 24 years, 3 Morris street, June 1.

Inquest No. 757—2d quarter. Meekim, Mary A., 18 years, 3 Morris street, June 1.

Inquest No. 1009—2d quarter. Thomas, William, 55 years, 28 Bowery, June 26.

Inquest No. 718—3d quarter. Hottenrath, Cath., 44 years, 395 Bowery, August 22.

Inquest No. 931—3d quarter. Pasant, Josephine, 31 years, Sturtevant House, September 14.

Inquest No. 7—4th quarter. Walcott, Jane Eliza, 16 years, 14 West 28th street, October 1.

Inquest No. 56—4th quarter. Strauss, Emma, 20 years, 90 Cortland street, October 7.

Inquest No. 281—4th quarter. Kelly, Timothy, 45 years, 2299 Fourth avenue, October 27.

Inquest No. 349—4th quarter. Rowan, Mary, 20 years, Presbyterian Hospital, November 2.

Inquest No. 422—4th quarter. Leamy, Daniel, 52 years, 48 Chatham street, November 9.

Inquest No. 463—4th quarter. Concannon, Margaret C., 22 years, 25 Third avenue, November 13.

Inquest No. 462—4th quarter. Concannon, Hugh, 23 years, 25 Third avenue, November 13.

Inquest No. 768—4th quarter. Mahoney, Honorah, 17 years, 4 Attorney street, December 15.

1883. Deaths from illuminating gas, 6.

Inquest No. 101—1st quarter. Culver, Andrew L., 58 years, 92 Cortland street, January 8.

Inquest No. 213—1st quarter. Schofield, Arthur, 83 years' 34 West 11th street, January 19.

Inquest No. 299—1st quarter. Tourmanski, Frank W., 28 years, 30 Bowery, January 27.

Inquest No. 654—1st quarter. Lawrence, Wm. S., 59 years, Putnam House, March 1.

Inquest No. 828—1st quarter. Mulcahey, Wm., 39 years, 48 Chatham street, March 17.

Nauschwitz, Elizabeth W., 40 years, Bowery and Canal street, Summit Hotel.

APPENDIX B. PAPER 6.

[AMERICAN GASLIGHT JOURNAL, NEW YORK, Friday, March 16, 1883.]

CARBURETTED POISON.

About five years ago a series of articles appeared in this Journal from the pen of Dr. Henry Morton, President of the Stevens Institute of Technology, Hoboken, N. J., pointing out the exceedingly poisonous qualities of carbonic oxide, and the danger to public health that might result from permitting too large a proportion of this constituent in illuminating gas.

Many have been the assertions on both sides of the question that have appeared since the publication of the articles referred to above; but it would seem that the facts which have been developed by its use would lead any reasonable mind to conclude that there is danger to public health from its use. At that time it was a matter of opinion, and an honest difference of opinion is always to be respected; but five years' use of water gas has certainly placed the matter beyond the pale of opinion. Previous to the introduction of water gas in New York City, for fifty years there is no record of death from inhaling coal gas; and although men engaged about the works and mains are often overcome, exposure to fresh air brings immediate relief, and it is said to be a fact that no person found alive was ever known to die from the effects of inhaling coal gas. People have, doubtless, been overpowered and smothered by coal gas under peculiarly favorable circumstances, but such cases are extremely rare, for coal gas does not contain enough of the only poison in illuminating gas, viz., carbonic oxide, to produce the blood-poisoning which is so fatal in cases of water gas suffocation.

One argument used is, that gas is furnished for lighting purposes. This is all very well if you are absolutely sure that

there are no leaks in the pipes ; for, if such should be the case, the air for breathing purposes becomes polluted, and the gas does enter as an element into the air for breathing.

Quantities of pamphlets and circulars of all kinds are distributed by both sides to show that the views taken by each are right. A pamphlet recently received from Richmond, Va., containing a minority report on this subject made by the Committee on Light, to the City Council, appears to treat the matter more as one of fact than theory. A list is given of the cases in New York and Brooklyn which have been published in the daily papers, giving date, name of paper, etc. This list extends up to about January 1. Since then there have been several other cases which we have added.

NAMES.	LOCALITY.	NEWSPAPERS.	DATE.
†John Gilleland	St. Charles Hotel	Times	Oct. 27, 1878.
*John Brown	31 Bowery	World	Nov. 8, 1878.
*Lorenzo M. Locoma	21 East 4th street	Times	Nov. 18, 1878.
†Dominick Hart	133 Crosby street	World	Dec. 20, 1878.
†Elizabeth Williams	31 Bowery	World	Nov. 8.
†Wm Rigby	133 Crosby street	World	Dec. 20.
†Thos. Knight	33 Crosby street	World	Dec. 20.
*Jerry Nichols	St. Cloud Hotel	World	April 25.
*Susan Cochrane	53 West 13th street	Tribune	Jan. 23, 1880.
†Mr. Augsley	New York Hotel	World	April 16, 1880.
†Mr. Broodhurst	"	World	April 16, 1880.
*John Donovan	115 West 32d street	Herald	May 23, 1880.
†Andrew Mackey	49 Whitehall street	Star	May 18, 1880
*Lewis Baker	French's Hotel	Herald	May 21, 1880.
*S. Lawson	New Southern Hotel	Times	June 4, 1880.
†Augustus Hagenori	45 Bowery	Times	June 25, 1880.
*J. Glospsky	Crook's Hotel	Times	Sept. 20, 1880.
†David Kearney	316 Greenwich street	Herald	Oct. 2, 1881.
†G. J. Maxwell	316 "	Herald	Oct. 2, 1881.
*Sophia Tugenito	Anson House	World	Nov. 1, 1880.
*Bertha Wies	338 Henry street	Telegram	Nov. 4, 1880.
*Thomas Coleman	Putnam House	Com'l Adver'r.	Dec. 3, 1880.
*Patrick Ferrigan	80 Duane street	News	Dec. 1, 1880.
†John Sloane	"	News	Dec. 1, 1880.
*S. Sherwood	Earle's Hotel	Telegram	Dec. 16, 1880.
*F. Borge	Summit Hotel	Times	Nov. 19, 1880.
†C. W. Davis	Sweet's Hotel	Telegram	Dec. 17, 1880.
*R. A. Stillwell	North River Hotel	Times	Dec. 24, 1880.
†Fredk. Albert	Summit Hotel	World	Dec. 27, 1880.
*Patrick Nolan	10 First street	Herald	Jan. 1, 1881.
*I. Hammersley	10 "	Herald	Jan. 1, 1881.
*R. B. Reynolds	Van Dyke House	World	Jan. 3, 1881.
†Fredk. Keal	39 Bowery	Tribune	Jan. 6, 1881.
†Joseph A. Grant	1355 Broadway	World	Jan. 12, 1881.
†Michael Lynch	328 East 27th street	Sun	Jan. 14, 1881.
*John Bunyan	New York Hotel	Sun	Jan. 22, 1881.
†John Galen	Central Hotel	Sun	Jan. 24, 1881.
†—— Knapp	"	Sun	Jan. 24, 1881.

NAMES.	LOCALITY.	NEWSPAPERS.	DATE.
*Henrietta Braundofer..	955 Third avenue......	Telegram....	Feb. 12, 1881.
*Barbara Wies.........	925 "	Telegram	Feb. 12, 1881.
*Gustave Bertline......	310 Broome street......	Sun..........	April, 3, 1881.
*Andrew O'Donnell....	Summit Hotel.........	Star..........	April, 8, 1881.
*Sophie Svenson......	200 West 56th street....	Tribune......	April, 8, 1881.
†Frank Watson.........	Van Dyke House.......	World	May 9, 1881.
†John McCarty.........	Grand Union Hotel.....	Tribune.....	Sept. 29, 1881.
*Rev. Abijah Green....	Hamilton House.......	Times........	Oct. 21, 1881.
*Joseph Caille..........	405 Sixth avenue.......	Tribune......	Nov. 11, 1881.
*Wm. Zimmerman......	Municipal Gas Works...	Sun..........	Oct. 16, 1881.
*Michael Coyne........	St. Vincent Hotel.......	Herald.......	Jan. 27, 1881.
*Thomas J. Durand....	Occidental Hotel.......	Post..........	Feb. 16, 1882.
*Richd. A. Stryker.....	Bridge Hotel...........	Telegram.....	Mar. 1, 1882.
*F. W. Hoffman........	North River Hotel......	Times........	Mar. 2, 1882.
†Emil Acoreie..........	Steamer Providence....	Telegram.....	May 5, 1882.
*Lily J. Brandt........	"	Telegram.....	May 5, 1882.
*James H. Langley.....	Newport Steamer.......	Tribune......	May 31, 1882.
†Lydia Coleman.... ..	106 East 14th street.	Tribune......	May 31, 1882.
†Daughter of the above.	106 "	Tribune......	May 31, 1882.
†Elliot Lavina..........	176 Washington street..	Tribune......	May 18, 1882.
*Wm Meakin..........	Eagle Hotel............	Herald.......	June 2, 1882.
*Mrs. Meakin..........	Eagle Hotel............	Herald.......	June 2, 1882.
*H. R. Covert..........	French's Hotel.........	Herald.......	June 2, 1882.
*Wm. Thomas.........	Van Dyke House.......	Tribune......	June 27, 1882.
†E. D. Miller..........	Cosmopolitan Hotel....	Telegram	July 7, 1882.
†Franz Stark..........	Castle Garden Hotel....	Times.......	July 7, 1882.
†M. Hartman..........	Broadway Hotel........	World........	Aug. 21, 1882.
†Georavini Romanollet.	70 James street.........	Herald..... .	Aug. 13, 1882.
†Angalo Lammino......	70 "	Herald.......	Aug. 13, 1882.
†Henry Conklin........	108 South street........	Telegram	Sept. 20, 1882.
*Jennie E. Walcott.....	14 West 28th street.....	Herald.......	Oct. 26, 1882.
*Emma Strauss.........	Glen Island Hotel......	Telegram.....	Oct. 7, 1882.
*Timothy Kelly........	2297 Fourth avenue....	Telegram.....	Oct. 27, 1882.
*Daniel Leary..........	1 Chambers street.....	Herald.......	Nov. 18, 1882.
*H. Robt. Petri.........	65 Bowery.............	Times........	Nov. 19, 1882.
*James Walker.........	Occidental Hotel.......	Telegram.....	Nov. 22, 1882.
*Annie Stademeyer.....	47 Bowery.............	Times	Nov. 30, 1882.
*Honora Mahoney......	4 Attorney street.......	Telegram...	Dec. 15, 1882.
†D. A. Flanagan.......	Sixth ave. cor. 44th st..	Tribune......	Dec. 28, 1882.
*Andrew L. Culver.....	112 West street.........	Sun..........	Jan. 10, 1883.
*Arthur Scholfield......	Hotel St. Stephen......	Sun	Jan. 20, 1883.
†—— Fernowsky.......	30 Bowery.............	Tribune......	Jan. 27, 1883.
†Christian J. Okeburg..	St. Andre Hotel.......	Telegram.....	Feb. 17, 1883.
†—— Johnston.........	Steele's Hotel.........	Morn. Journ'l.	Feb. 21, 1883.
†—— Cannon....... ..	"	Morn. Journ'l.	Feb. 21, 1883.
*J. Lawrence...........	Putnam House.........	Telegram.....	Mar. 1, 1883.
†Cortney Goodwin.....	25 Coenties Slip........	Morn. Journ'l.	Mar. 2, 1883.
*Matilda Hogfeldt.....	296 Sackett street.... .	Union........	April 15, 1881.
*Patrick Cook..........	Fulton Mun. Gas Works.	Union-Argus..	July 11, 1881.
*John Agins...........	Clinton House.........	Union-Argus..	Oct. 13, 1881.
†W. King, of Vermont .	"	Eagle........	May 13, 1882.
*Wm. Hueske..........	Annex Hotel, 12 Fulton.	Eagle........	Oct. 9, 1882.
*Theodore Hastke......	" " .	Eagle...... .	Oct. 9, 1882.
*Susan Fendick........	111 Fort Green Place...	Eagle........	Oct. 28, 1882.

* Dead. † Suffocated.

Theories may be retracted and statements modified, but here is a record that should attract the attention of those whose care it is to protect the public health; and no amount of explanation can bring back to life those who have already died from the effects of the poison. The water gas itself is but a carburetted poison. Its insidious influences have often, no doubt, been felt by those who did not know what was affecting them, and there are doubtless hundreds of cases never mentioned in any newspaper where illness, disease, and ultimate death have occurred from inhaling this dangerous element. If one hundred people are killed in five years in New York, where only two-fifths of the gas is carburetted poison, what would the number have been if all the gas sold were of this poisonous character? Are the statistics of the Health Department arranged for this new order of things? A new column will be required, headed "Killed by water gas." It would seem that a new source of increase in the death rate would attract the attention of the health authorities; and that they could not much longer disregard facts like those submitted above.

APPENDIX B. PAPER 7.

[List of injuries furnished by Municipal Gaslight Company of New York, and said to be all due to coal gas; received too late for any attempt at verification.]

UNITED STATES.

1849. St. Louis. Sauerbier, wife, two children and a journeyman suffocated. The wife and one child were found dead; little hope for the others.—Scientific American, v. 7, p. 149.

1864. Judge Crane of Paterson, N. J., died "out west."—American, G. L. J., v. 5, p. 353.

1865. February 3. Brooklyn, 228 Washington street, Barnett Van Buren, 43 years; Eunice Ann Van Buren, his wife, 35 years; Ida Van Buren, 12 years; Edward Van Buren, 7 years; Myron Van Buren, 4 years; all suffocated. Myron was found dead; Barnett is expected to die.—N. Y. Times, February 4, 1865; p. 8, c. 4.

NOTE.—From information obtained from ex Coroner Lynch, the cases were due to stove coal gas, a Franklin stove filled with coal and damper entirely closed. J. H. R.

1865. December 24. Chicago. Chas. John Blachsiae, Adolph Blachsiae, James McAuliff, John Johnson, Louis Lout, Johnny White, all suffocated in a boarding house; the first five were

found dead ; White's recovery doubtful.—N. Y. Times, December 31, 1865, p. 3, c. 7. December 29. Worcester, Mass. Artemus Ward and wife died.—N. Y. Times, December 31, 1865, p. 5, c. 1.

1873. January 1. Auburn. A man suffocated in hotel, blew out the gas.—American G. L. Journal, v. 17, page 42. December 22. Cincinnati, Ohio. Edward Schwarz Voegel, wife and child suffocated ; the man and child were found dead, the wife died afterward.—Am. G. L. Journal, v. 19, p. 5.

1875. May 5. Buffalo, N. Y. Edward Connolly and his son died ; leak in the service pipe.—American G. L. Journal, v. 22. February 19. Providence, R. I., Wickendren street. Hugh Trainor, wife and children suffocated ; Lawrence Lynch and wife suffocated ; Mary Josephs suffocated. Lynch and wife may recover ; Mary Josephs is expected to die.—Am. G. L. Journal, v. 24, p. 120.

1878. November 17. Buffalo, N. Y. August Bolle died.—N. Y. Herald, November 18, 1878. November 20. San Francisco, Cal. Gabriel Castro died.—San Francisco Courier.

1879. March 18. Bath, Me. Jno. Scrafford died ; superintendent gas works.—Telegram, March 18, 1879. March 18. Providence, R. I. Frank W. Tucker died.—Telegram, March 18, 1879.

1880. October 26. New York, 311 East Eleventh street, Wm. Drummond suffocated and taken to hospital.—Telegram, October 26, 1880.

1881. April 10. Albany, N. Y. Esther Burton suffocated. —N. Y. Paper, April 11, 1881. May 7. Chicago, Ill. John Hopkins died.—N. Y. Paper, May 8, 1881. November 9. New York, 334 Bowery. Peter Kerrellhoff suffocated.—Telegram, November 9, 1881. November 19. Philadelphia, Pa., Hotel Lafayette. F. Tilford and wife suffocated.—Telegram, November 19, 1881.

1882, February 5. New York, 226 East Eleventh street, Patrick Geoghegan suffocated.—Sunday Mercury, February 5, 1882. March 19. Boston, Mass., International Hotel. Frank Hayes died.—N. Y. Herald, March 20, 1882. May 6. Steamer Providence, Fall River Line, on trip to New York ; L. Corsi died ; Lillie Bent died.—N. Y. Times, May 6, 1882. May 25. Steamer Bristol, Fall River Line, on trip to New York. J. W. Langley died.—N. Y. Times, May 26, 1882. July 7. New York, Cosmopolitan Hotel. E. D. Miller suffocated.—Telegram, July 7, 1882. October 14. Jersey City Heights, N. J. Annie Buck died.—N. Y. Times, October 14, 1882. November 13.

Batavia, N. Y. W. Tolan died.—Lockport Union, November 13, 1882. December 27. Philadelphia, Pa., City Hotel. Isaac Batten died.—N. Y. Tribune, December 28, 1882.

FOREIGN.

1859. Raunds, England. Rev. Robert Abbott died.—Am. G. L. Journal, v. 1, p. 81.

1860. January. Osset, near Wakefield, England. Elizabeth Redfearn and her daughter Hannah suffocated by gas from broken street main; restored to consciousness; the daughter recovered; the mother sank and died a few days later.—The Engineer, v. 9. p. 55.

1864. Fulham, England. George Reid, at the Imperial Gas Works, died.—Am. G. L. Journal, v. 5, p. 97.

1865. February 12. Glasgow, Renfrew street. Mrs. M. McMillan and son Hugh suffocated by gas from leaking main; Mrs. McMillan was found dead; Hugh recovered.—The Times, February 15, 1865; p. 9, c. 6.

1870. November 14. Leeds Moor, Crescent Road. Mrs. Jane Wood, Selina Wicks Wood, John Henry Tighe, Ann Elizabeth Tighe, John Tighe, Mrs. John Tighe, were all suffocated by gas from a leaking street main; the first four were dead when found, the last two insensible; John Tighe is expected to die, his wife to recover.—The Times, November 15, 1870; p. 6, c. 3

1872. October 19. London, Mile End. One man killed and two suffocated while stopping a leak in a main.--The Times, October 21, 1172; p. 5, c. 4.

1873. Feb. 1. Manchester, Mason street. Six persons suffocated by gas from broken service; four had to be removed to the infirmary.—The Times, Feb. 3, 1873; p. 11, c. 4. April 4. Dundee. Mrs. McNab was found unconscious on April 7.—The Times, April 8, 1873; p. 12, c. 5. April 28. Leicester. George King killed and William Collins suffocated at the Leicester Gas Works.—The Times, April 29, 1873; p. 12, c. 4. March 31. Dundee, Lowndes Alley. Samuel Bowes, wife, son and daughter were found dead; cause, escape of gas.—The Times, April 2, 1873; p. 12, c. 4. September 23. London, Wellington College. William Alexander Clifford died from gas poisoning.—The Times, September 26, 1873; p. 6, c. 3. November 27, Mr. McCullough was found dead and his wife insensible; leak at the meter.—The Times, November 28, 1873; p. 9, c. 5. November 29. Arno Vale, near Bristol. Mary Boylan died from gas poisoning at the convent of the Good Shepherd.—The Times, December 2, 1873; p. 7, c. 6.

1876. October 22. Antwerp. At a restaurant near La Bourse, two servant girls were dead when found; one died the next day, and for the fourth there is not much hope.—The Times, October 25, 1876; p. 9, c. 5.

1877. January. Blackley, England. James Smethurst died at Ashenhurst Works.—J. of Gas Lighting, v. 29, p. 157. March. Canonhill, Scotland. George Peattie, foreman at the Edinburgh and Leith Gas Company's Works, suffocated, revived, and then died.—J. of Gas Lighting, v. 29, p. 352. May 2. Springfield, Clemsford, England. Charles Wright suffocated at Essex County Jail; died May 4.—J. of Gas Lighting, v. 29, p. 784. August 15. Port Glasgow. Ropework Lane. Mrs. Elizabeth Lang died.—J. of Gas Lighting, v. 30, p. 385.

1878. January 20. Dundee, Foundry Lane. Mrs. Thomas Fields and daughter Eliza died.—J. of Gas Lighting, v. 30, p. 167. February 11. Sheffield, Clarke Square. Dr. Gwinne suffocated by gas leaking from main.—The Times, February 14, 1878; p. 9, c. 6. February 17. Finsbury, England, 35 Bath street. Mrs. Elizabeth Palmer, age 52, suffocated; she died February 21.—J. of Gas Lighting, v. 31, p. 167. December 25. Cork, Kyrl's street. A family named Butler poisoned by gas; the three children were found dead, father and mother unconscious; the former died.—The Times, December 26, 1878; p. 8, c. 3.—J. of Gas Lighting, v. 32, p. 955. June 28. Belfast, Ireland. Two Misses Hamilton died.—J. of Gas Lighting, v. 32, p. 64. December 4. Salford, England. Mary Ann Lane found insensible; died.—J. of Gas Lighting, v. 32, p. 934.

1879. February 3. Bradford, England. Father, son and servant girl died.—J. of Gas Lighting, v. 33, p. 245. April 12. Huntley, N. B. William Wilson died.—J. of Gas Lighting, v. 33, p. 604. September 27. Halifax, England. Jeremiah Sullivan and wife Theresa died at Junior Liberal and Exchange Club.—J. of Gas Lighting, v. 34, p. 515.

1880. January 10. Southport, England. Elizabeth Doyle found insensible.—J. of Gas Lighting, v. 35, p. 66.

1881. February 28. London, South Metropolitan Gas Works. Thomas Goldsmith died.—J. of Gas Lighting, v. 37, p. 449.

1882. September 5.. East Middlesex, England. John Pepin died at the Shoreditch Works of the Gaslight and Coke Company.—J. of Gas Lighting, v. 40, p. 486.

1880. November 26. Paris, France. Miss Thannberg died; Miss Chevandiere died.—N. Y. Times, December 12, 1880.

APPENDIX C. PAPER 1.

THE BROOKLYN GASLIGHT COMPANY,
180 Remsen Street,
BROOKLYN, N. Y., June 7, 1883.

Please find herewith the information asked for in your note of the 5th instant.

This company commenced sending out illuminating gas in October, 1849.

Our "send out" up to January 1, 1883, has been, as per statement herewith, 8,726,564,492 cubic feet.

We shall be pleased to furnish any further information desired.

Respectfully yours,

JAMES H. ARMINGTON,

President and Engineer

1849 and 1850	23,372,000
1851	32,334,000
1852	53,949,000
1853	82,956,000
1854	120,046,000
1855	128,768,000
1856	139,843,000
1857	153;284,000
1858	170,440,220
1859	199,166,330
1860	224,994,290
1861	216,558,650
1862	222,326,270
1863	221,116,780
1864	221,843,390
1865	252,631,882
1866	281,396,510
1867	325,458,450
1868	374,366,360
1869	397,500,170
1870	403,205,900
1871	431,499,150
1872	453,553,330
1873	438,334,810
1874	406,685,000
1875	406,172,000
1876	297,196,000
1877	306,424,000

1878	321,773,000
1879	333,303,000
1880	338,412,000
1881	359,668,000
1882	387,987,000
	8,726,564,492

Amount of gas made by the Brooklyn Gaslight Company since their organization is, 8,726,564,492 cubic feet.

JAMES H. ARMINGTON,
President and Engineer.

APPENDIX C. PAPER 2.

OFFICE OF THE NASSAU GASLIGHT COMPANY,
No. 959 Fulton Street,
BROOKLYN, N. Y., June 7, 1883.

In reply to your favor of the 5th instant, beg to say that we first supplied gas in May, 1873. The following is statement of gas supplied since that time :

1873	59,000,000	feet.
1874	110,000,000	"
1875	114,000,000	"
1876	89,000,000	"
1877	96,000,000	"
1878	101,000,000	"
1879	103,000,000	"
1880	109,000,000	"
1881	127,000,000	"
1882	146,000,000	"

Yours respectfully,

S. T. WHITE,
Secretary.

APPENDIX C. PAPER 3.

FULTON MUNICIPAL GAS COMPANY,
342 Fulton Street,
BROOKLYN, N. Y., June 8, 1883.

Your note of June 5 at hand. This company commenced supplying gas in May, 1880.

To May, 1881, supplied	145,000,000	cubic feet.
" 1882, "	177,000,000	"
" 1883, "	278,000,000	"

Yours respectfully,

H. M. BENEDICT, *President.*

APPENDIX C. PAPER 4.

Table showing the production of Coal Gas since 1848, and of Water Gas since 1878, in cubic feet, in the cities of Brooklyn and New York.

YEAR.	BROOKLYN. Name of Company.							NEW YORK. Name of Comp'y					
	Brooklyn.	Nassau.	Fulton Municipal.	Williamsburg.	People's.	Metropolitan.	Citizens'.	Manhattan.	Metropolitan.	Harlem.	Municipal.	New York Mutual.	Knickerbocker.
1849 and 1850	23,372,000												
1851	32,334,000												
1852	53,949,000												
1853	82,956,000												
1854	120,046,000												
1855	128,768,000												
1856	139,843,000												
1857	153,284,000												
1858	170,440.220												
1859	199,166,330												
1860	224,994,290												
1861	216,558,650												
1862	222,326,270												
1863	221,116,780												
1864	221,843,390												
1865	252,631,882												
1866	281,396 510												
1867	325 458,450												
1868	374,366,360												
1869	397,500,170												
1870	403,205,900												
1871	431,499,150												
1872	453,553,330												
1873	438,334 810	59,000,000											
1874	406,685,000	110,000,000											
1875	406,172,000	114,000,000											
1876	297,196,000	89,000,000											
1877	306,424,000	96,000,000											
1878	321,773,000	101,000,000											
1879	333,303,000	103,000.000											
1880	338,412,000	109,000,000	To May '81										
1881	359,668,000	127,000,000	145,000,000										
1882	387,987,000	146,000,000	177,000,000										
1883	....	....	278,000,000										
Total	8,726,564,492	1,054,000.000	600,000,000										

According to an estimate furnished by Mr. Benedict, the annual production of Illuminating Gas in Brooklyn, is 4,000,-000,000 cubic feet, of which about one half is Water Gas.

APPENDIX C. PAPER 5.

FULTON MUNICIPAL GAS COMPANY,
342 Fulton street
BROOKLYN, April 10, 1883.

The Lamp and Gas Committee having submitted to you the question, "To what extent the use of Water Gas is more dangerous to public health and life than is the use of coal gas?" I take the liberty to present a few considerations in the matter which may be worthy of your attention, and state some facts which you can have corroborated.

1. The following companies in New York make and sell water gas.

New York Gaslight Company,	sales per annum, cubic feet	600,000,000
Municipal	" " "	650,000,000
Knickerbocker	" " "	150,000,000
Mutual	" naphtha, wood and coal gas, "	600,000,000
		2,000,000,000

As the total consumption of gas in New York is about 4,000,000,000, about one half is water gas.

2. This company is now making at the rate of 400,000,000 cubic feet water gas per annum, supplying its own customers and also the Citizens', Metropolitan and People's Gas Companies, in their districts. The Brooklyn, Nassau and Williamsburgh Gas Companies are making about 700,000,000 cubic feet coal gas per annum. Total, say 1,100,000,000 cubic feet.

3. The companies making and supplying water gas, in New York and Brooklyn, have adopted it after thorough investigation of its qualities and adaptation to public use, and from practical results find it superior in lighting and heating power to coal gas, and from equal conditions of use less dangerous to public health and life. Equal quantities of water gas compared with coal gas give the public from 30 to 50 per cent more light, which, at equal prices, is a gain to that extent, in light, or in economy. Where water gas is used it is apparent to everybody capable of judging that the streets are better lighted and therefore made safer at night, and public and private houses and buildings far better illuminated.

4. The products of combustion of water gas are less deleterious to health and less injurious to furniture and decorations than those of coal gas, by reason of its greater freedom from sulphur and sulphur compounds and vapors.

5. The charge is made that water gas produces a greater blood poison than coal gas. This is not true. The workmen at water gas works, who are constantly exposed to the fumes of water gas in the different processes of manufacture, working in it day and night, have never been injuriously affected, and are as healthy as any set of workmen employed in manufactures. Those most exposed to inhaling the gas when changing the time in the purifying houses suffer less inconvenience than the same class of workmen in coal gas works. The sparrows build their nests in the retort houses where the gas is made and are almost always to be found in the buildings winter and summer. Mothers and nurses frequently bring their children who are suffering from throat ailments and difficulty in breathing, into the purifying houses and say that it benefits them to stay awhile there.

6. The loss of life reported from the use of water gas (or rather the abuse) by allowing it to escape unconsumed in hotels, boarding-houses, &c., is claimed to be on the increase and is given as evidence of greater danger from water gas than coal gas. No facts have been or can be produced to prove that death would not as certainly result if coal gas were inhaled under the same conditions that have produced suffocation by the inhalation of water gas, and there are facts which justify the opinion that water gas is not as deadly in its effects when inhaled as coal gas. The competition with rival interests, occasioned by the rapid advance in the use of water gas, has stimulated efforts to accumulate and spread before the public all cases of accident which have occurred, near or remote, from inhaling it. Then, a larger floating population than ever before is moving through these cities, not acquainted with the uses or dangers of gas, and as water gas is now chiefly used in hotels and boarding houses, to which they resort, more cases of suffocation are reported to have occurred, and the most is made of these reports to the detriment of water gas, by parties interested in rival coal gas and electric companies.

7. It is evident in examining the records of the Board of Health and Coroners' reports in the two cities, that formerly there was not the same care in entering reports of suffocation by coal gas, and that medical terms for suffocation were often used which do not positively identify the cases as occurring from inhaling illuminating gas. Hence a comparison as to the fatality by the two gases would not be accurate and trustworthy.

8. Judging from accidents reported there is more danger from explosion in the event of leaks of coal gas than from water gas. The analysis of the two gases shows that there is a foundation for this difference in their respective constituent elements. This company does not claim to be exempt from danger of explosions in case of leaks, but thus far no such accident has occurred to it.

9. The presence of a larger proportion of carbonic oxide in water gas than in coal gas is claimed to constitute the chief objection to its use. Authorities differ in this regard; the old tests for carbonic oxide were all made with coal gas, and varying proportions of that element in combination with the other ingredients of coal gas may have justified certain conclusions derived from its analysis. But it does not follow that these conclusions are at all applicable to water gas. Wood gas, as made at many places in Europe and this country, carries a larger proportion of carbonic oxide than coal gas or water gas. We have never heard of its being objected to on that account. Carbonic oxide often escapes in large quantities into rooms where anthracite coal is burned in stoves and furnaces, owing to imperfect or obstructed pipes or flues. Illuminating gas is therefore not the only carrier into houses of that so-called deadly element. Would not an investigation in the interest of public health be quite as important in regard to the manner of using anthracite coal and kerosene, in view of the accidents occurring from their use?

10. The powerful influence of coal gas companies with the legislatures of New Jersey and Massachusetts has been successfully exerted to forestall the introduction of water gas in those States, by securing legislative action limiting the amount of carbonic oxide to ten per cent in gas. A movement, however, is now being made to repeal those acts.

At your convenience I shall be pleased to have you inspect our works and methods of manufacture, and examine the workmen in reference to their experience in coming in contact constantly with this so-called poisonous water gas.

Yours very respectfully,

H. M. BENEDICT,

President.

APPENDIX C. PAPER 6.

FULTON MUNICIPAL GAS CO.,
342 Fulton Street,
BROOKLYN, June 2, 1883.

In reply to your communication of May 29th requesting an account of the process of making gas by this Company, I submit the following statement. The furnaces or gasogenes contain anthracite coal fully ignited. Steam (alternating with air to maintain the heat) is introduced into the gasogenes forming the so-called water gas. This gas is conducted into carburetters containing naphtha vaporized by heat, which, uniting with the gas, passes into retorts highly heated, and forms a permanent gas. This gas then passes through condensers, scrubbers, purifiers, and station meters into the holders, ready for distribution. The only materials used are steam, anthracite coal, and naphtha. The gas is purified with lime, and is freer from impurities than gas from other coals. The candle power at the works averages 29 candles. The process is not deleterious to the health of the workmen.

Yours respectfully,

H. M. BENEDICT,

President.

FULTON MUNICIPAL GAS CO.,
342 Front Street,
BROOKLYN, N. Y , April 26, 1883.

In reply to your inquiry of April 16th, I have no knowledge of cases of illness or death from illuminating gas, except where they were produced by suffocation from inhalation of the gas or by explosion. The facts as to such cases would be better stated by the records of the coroner's office or by attending physicians. I have already sent you a record of such facts as I have been able to procure, and will send in any further information I may get.

Very respectfully,

H. M. BENEDICT,

President.

FULTON MUNICIPAL GAS CO.,
342 Fulton Street,
BROOKLYN, N. Y., August 26, 1883.

Your communication of April 17th is received. This company was supplying gas to the Clinton House, October 9, 1881;

Annex Hotel, October 9, 1882 ; 111 Fort Greene Place, October 28, 1882. I am informed that the Brooklyn Gas Co. supplied 362 Pearl street, January 24, 1882. The Citizens' Gas Co supply the district in which 296 Sackett street is located, and that company is supplied with gas from our works.

Very respectfully,

H. M. BENEDICT,

President.

THE BROOKLYN GASLIGHT COMPANY,
180 Remsen street,
BROOKLYN, N. Y., May 31, 1883.

Please find herewith a short description of the process in use by this company for making illuminating gas.

Should you wish to have a more lengthy description, in use by us, I will cheerfully prepare the same. Trusting that I may not be deemed intrusive if I suggest that the gas made by us should be distinguished as "Illuminating Gas," I am

Respectfully yours,

JAMES H. ARMINGTON

President and Engineer.

Process of manufacture of coal gas by the Brooklyn Gaslight Company :

This company manufactures illuminating gas from cannel and coking coals. A mixture of these coals and cannel is put into a highly heated clay retort and the volatile portions of the coal and cannel, consisting of tar, oil and gases, are driven off by the heat, the gases are collected, condensed, washed or scrubbed, purified by hydrate of lime from the sulphur compounds, carbonic acid and all deleterious products, tested as to purity and illuminating power and stored in the gas holders ready for consumption.

BROOKLYN, N. Y. May 31, 1883.

APPENDIX C. PAPER 7.

THE PEOPLE'S GASLIGHT COMPANY,
419 Myrtle Avenue,
BROOKLYN, April 19, 1883.

Replying to your favor, will say: The facts relating to suffocation and deaths from inhalation of gas have come to my attention from newspaper reports from time to time, extending over a period of time as long as I can remember.

Yours very truly,

EDWIN LUDLAM.

OFFICE OF METROPOLITAN GASLIGHT COMPANY,
No. 563 Atlantic Avenue,
BROOKLYN, N. Y., April 18, 1883.

Replying to yours of yesterday: We do not know of any cases, whether fatal or not, where illuminating gas has been charged with having produced the illness.

Respectfully,

CHAS. H. STODDARD,

Secretary and Treasurer.

APPENDIX C. PAPER 8.

Showing some of the "flats" or large apartment houses, and the number of consumers of the gas manufactured by different companies.

FLAT.	LOCATION.	Total Number Consumers.	Municipal.	Metropolitan.	Manhattan.	Mutual.
Albany	Broadway and 51st street	38	37	1		
Amsterdam	40th street and 6th avenue	31	25	6		
Berkshire	500–502 Madison avenue					
Boston	34–36 West 59th street	13	7	6		
Elise	954 8th avenue	12	5	7		
Glencoe	849–853 7th avenue	33	26	7		
Irvington	1693 Broadway	8	7	1		
Knickerbocker	2 West 14th street	9	8	....	1	
Kensington	4th avenue and 57th street	17	15	2		
Lexington	153–165 East 49th street	49	45	4		
Oxford	131–141 West 56th street	36	32	4		
Orleans	975–979 8th avenue	33	31	2		
Lorimer	30-32 West 59th street	13	10	3		
Saratoga	Broadway and 52d street	22	17	5		
Union	111–121 West 56th street	62	51	11		
Van Corlear	55th to 56th street and 7th avenue	38	33	5		
Victoria	777 8th avenue	9	4	5		
Vienna	341 West 23d street	22	4	....	18	
Washington	940 8th avenue	9	1	8		
Strathmore	Broadway and 52d street	18	17	1		
	93-99 3d avenue	......	4			
	353-355 3d avenue	.....	2			
	516 3d avenue	......	5			
	396 3d avenue	......	2			
	540 3d avenue or 162 East 36th st.	......	8	....	....	2
	519 6th avenue	......	4	....	....	1
	529 6th avenue	......	4	....	....	1
	531 6th avenue	....	2	....	....	3
	619-621 8th avenue	.....	12			
	110 West 40th street	......	2			
	112 West 40th street	......	1			
	925 Broadway	......	1	....	3	
	377 4th avenue	......	4	....	1	
	240 6th avenue	......	1			
	244 6th avenue	......	9			
	201 West 25th street	......	5		3	
	114 West 23d street	......	3	....	1	
	817-819 Broadway	......	6			
	25 3d avenue	......	2			
	417 Broome street	......	2			
	21 East 14th street	......	2			
	238 West 14th street	......	5	....	1	
	842 3d avenue	......	1	1		

APPENDIX C. PAPER 9.

A NEW PROCESS OF MAKING WATER GAS.

BY THOS. B. FOGARTY.

A PAPER READ BEFORE THE AMERICAN GAS LIGHT ASSOCIATION, OCTOBER 18, 1882.

We are all aware that in every manufacturing process there is more or less waste of the raw material; and it is the province of the student in his library, the scientific chemist in his laboratory, the cultivator upon his farm, the botanical and geographical explorer in his travels and explorations, and the manufacturer in his workshop, to lend his aid in producing therefrom valuable products, and to add to the general wealth by converting into a commodity, useful in the arts or in the economy of daily life, a hitherto waste and undeveloped product.

Each and all of us may thus contribute more or less to the general good of mankind. Every one can contribute his quota to the general stock of information—can point out or suggest some pathway to useful discovery—some unperceived product seemingly fitted for a particular purpose, or direct attention to a particular staple which has not been so generally utilized as it might have been. Nature has yet in her storehouse many materials awaiting the discovery of man, fitted for the rapid advance of civilization and our domestic comforts. Each one, in his own range of observation, may add to the general stock of improvement, and discover something new, calculated to sustain and support his race, or to benefit his particular business or profession, and thereby contribute to the progress of the age.

In bringing to your notice, as I am about to do, a process of manufacturing water gas which, without egotism, I may claim to be a startling innovation upon established ideas and usages, I only ask for a calm consideration of the facts which I shall lay before you, asking you to prejudge or condemn nothing until you shall have mastered the substance of what I have to say; reminding you that what I am about to propose is not a whit more startling or extraordinary than the artificial production of butter, of sugar, or of the countless products of coal tar, and saying to you, in the words of Mr. Samuel Clegg, Jr., "He is a bold man who at the present day condemns a new thing without very deliberate consideration, and he is an imprudent one if he accepts for truth everything that is advanced in favor of a new thing without the same precaution."

I am fully aware that, in introducing to your notice a new process of making water gas, I may expect to be met with the prejudice with which every new departure from old established customs and usages is sure to be regarded.

If experience has shown that even in ordinary manufacturing processes, and in the usages and common avocations of daily life, a wide departure from established practices and precedents is justly regarded with disfavor and suspicion, and if it is pre-eminently reasonable and just that this should be so, I must expect that the attempt to introduce a startling innovation upon the present approved methods of making water gas will be received with the most extreme caution; for, independently of the great expense which a radical change in the process of manufacturing necessarily entails, the risk of failure in the supply of gas, involving as it does such serious consequences to an entire community, is paramount to every other consideration, and justly renders the gas engineer distrustful of change and conservative in his ideas.

However conservative the gas engineer may be, and however distrustful of change, he cannot shut his eyes to the fact that the great want of the present time is cheap gas. The cry which is unceasingly heard upon both sides of the Atlantic is a loud and constantly increasing demand for cheap gas—for increased economy in construction, in manufacture, in distribution, and in consumption.

During the past few years—and especially since the electric craze, as it may well be called, has taken possession of men's minds and purses—the attention of the gas community has been earnestly directed to and fixed upon the absolute necessity of increased economy in the manufacture, supply, and consumption of their staple. Mr. W. Mackenzie, of Dunfermline, said, at the meeting of the North British Association of Gas Managers in July last: "It is abundantly evident that cheaper gas must be made and supplied, and to accomplish this our energies must be at once directed. Economy, then, must be the order of the day; and I am persuaded we shall not be found lacking in desire to inquire into and take advantage of such new and improved methods as may be devised and submitted to us for this end."

In addition to this, there is among the people generally a growing appreciation of the great value, cleanliness and economy of gas as a source of domestic heat, it being generally acknowledged that the only obstacle to its general adoption for cooking and heating is the high price at which it is sold. Any process,

therefore, which promises such a marked reduction in the cost of gas as will enable it to be supplied to the consumer at a greatly reduced price, must have an interest for the gas engineer.

Although the past few years have been productive of marked economies as respects fuel, labor, and yield of gas, as well as in the several appliances for using it, whether for the purposes of light or heat, there is among the gas fraternity a strong and growing sentiment that, so far at least as regards increased economy in the cost of manufacture, the most promising field for inquiry and experiment is the increase and profitable utilization of the residuals produced in the process.

Indeed, to so great an extent has the feeling that the residual products of the gas manufacture will, in the near future, more than repay the entire cost of production, taken hold of the minds of the gas world, that we hear it prophesied almost simultaneously upon both sides of the Atlantic that the day is not far distant when gas will be the residual product, and the business of making and distributing it will be tributary to and dependent upon other manufactures.

We find in the London "Journal of Gas Lighting," of November 30, 1880, a paper read by Mr. G. E Davis, before the Manchester Scientific and Philosophical Society, in which he asked, "What would happen to the vast industry connected with the manufacture of gas if the electric light took the place of gas?" And the answer he gave was, "Simply nothing. There would spring up, near the coal pit banks, distillers of coal merely—manufacturers who would distill coal at a low temperature in order to produce tar, and they would call the gas a bye-product."

Again, we find that in the inaugural address of Mr. Charles Hunt, delivered before the British Association of Gas Managers, as reported in the "Journal of Gas Lighting," of June 14, 1881, he makes use of these remarkable expressions: "Above all, the production of ammonia is in the highest degree worthy of investigation, not alone on account of its rising value as an article of commerce, but also of the cause of the hopes that are very properly based upon its known adaptability as a most facile purifying agent. It is not by any means certain that the combination within the retort of the two elements of which ammonia is composed is beyond our control, recent experiments tending to show that this is accelerated by high heat, or, at all events, that by far the largest portion of the ammonia is produced toward the end of the process of distillation."

And again we find reported in the "Journal of Gas Lighting," September 13, 1881, a paper by Mr. G. Valentine upon "Two New Processes of Gas Purification, based upon the Direct Utilization of its Impurities in the Production of Commercial Salts," from which I extract the following: "We may say, then, that in time the scale of gas manufacture will be reversed, coal will be distilled for the value of its present bye-products, and gas will be the bye-product. Experiments, then, are wanted in the way of research. Take, for instance, the cause of the formation of ammonia in the distillation of coal. What quantity, if any, is formed from the nitrogen of the air? If any, the quantity could be increased to any extent by taking into account the temperature and nascent state of nitrogen and hydrogen in the presence of red-hot carbon. Gas works will then be more appropriately called chemical works."

And still again, we find it reported in the "Journal of Gas Lighting," of August 8, 1882, that at the last meeting of the North British Association of Gas Managers, Mr. Young, of Clippens, whom you all know, at least by reputation, read a most remarkable paper, in which he speaks of new works which he is erecting, and in which the following suggestive passage occurs: "If we are successful in obtaining 1 cwt. (112 lbs.) of ammonia from each ton of coal carbonized in our works, which I have no doubt will be accomplished, and at the same time produce some 50,000 cubic feet of powerfully heating water gas, I am satisfied that the gas manufacturing industry would be placed upon a sounder basis than ever. Coal will in all probability be the great source of power for ages to come. Electricity may and most likely will be the mode of motion found most effective in eliminating the energy of the coal to produce the results which we desire; but so far as we can see at present, the power stored in the coal can be most economically converted into electrical energy by gasifying the coal and using the gas in a gas machine, more particularly since we shall be able to recover the nitrogen as ammonia, as a bye-product from the gasifying of the gas." He considered that the day was not far distant when, instead of the fuel being sent out as now sold, it would be disposed of solely in a gaseous form, and they would have, in addition, the nitrogen in the shape of ammonia.

We find the same feeling existing among ourselves, for we have heard Mr. George Shepard Page declare, in his lecture upon residual products, delivered before you at your last meeting, that "With these new products that are being obtained we may soon expect to realize what the late Dr. Letheby said would

be the result in the future, although he might not live to see it, 'when gas would be the residual product.' Had his life been spared to the age of many I see before me Dr. Letheby would have witnessed the fulfillment of his prophecy."

And again, we find that Mr. Thos. Butterworth, President of the Western Gas Association, made the following pertinent remarks in the delivery of his inaugural address, at the meeting of the Association in May last: "I am credibly informed that some of our English brethren are so taking care of the sulphur impurities as to realize from them the costs of labor in purification. Now, in Illinois alone, we have 50,000 miles of gas coal formations, capable of turning out 7,000 tons to the acre, and each ton containing nearly 5 per cent. of sulphur. When we gas men take out that sulphur in a merchantable form (and some of us will yet find out how to do it), then by what name will we be known? Will it be gas men, sulphur extractors, tar and coke distillers, managers of sulphate works, or shall we be known as manufacturers of some one of the coal tar dyes that our friend Page names by the hundred? When these and other forms of impurities become a source of revenue—and they surely will in the near future—what then will be the selling price of good 16-candle gas? If it is not given away, it will be sold at a nominal sum—less than $1 per thousand cubic feet."

Indeed, the evidence is all around us that the feeling is general and widespread, that in the near future we will see the entire cost of manufacturing gas repaid by the sale of residuals. It is stated that the Paris Gas Company have already succeeded in recouping themselves for the cost of manufacturing their gas by the sale of residuals; and we hear that some of the English companies derive from this source a revenue equal to 70 per cent. of the cost of their coal.

But this movement has already left the realm of theory and entered the domain of fact. Mr. Young, of Clippens, is now erecting works capable of distilling 350 tons of shale per day, for the purpose of producing heating gas and ammonia; and we find in the "Journal of Gas Lighting," of September 12, 1882, the statement that Messrs. R. Damster & Sons, of Elland, York, England, are now erecting works for the carbonization of 100 tons of small coal daily, to begin with, for the purpose of obtaining tar and ammonia, which will be fully treated in the works. The gas will in this case be the residual product, and will not be prepared for sale, but will be used for heating the retorts. It is further stated that the contemplated establishment will cost £24,000, and that the engineers in charge are confident that the enterprise will be entirely successful.

It may now be asked, What about the new process of making water gas that we expect to hear about? To which I answer: The chief characteristic of the new process is the simultaneous production of excellent heating gas, ammonia, and carbonates of soda, and that the process is so wide and radical an innovation upon established usages and precedents that, for the sake of obtaining a fair consideration for what I have to propose, I have deemed it a safe, prudent, and wise course to dilate to some extent upon the subject of residuals, and to endeavor to impress upon you their great importance, hoping thereby to convince you that, if I am crazy upon the subject, there is method in my madness, and that I am at least in good company; for I have, as I have shown, the indorsement and support of some of the best and brightest intellects in the profession.

After many years of trial, the manufacture of water gas has been brought to a high state of perfection, but it is still defective in two very important particulars.

In the first place, it cannot be denied that the very percentage of carbonic oxide which it contains is at least very objectionable, not only on account of the well known poisonous qualities of this gas, but also on account of its injurious effect upon luminous flames; it being well known that gas lights in which this gas is largely prevalent are easily blown out, to which cause many of the deaths occurring through the inhalation of this gas are attributed by some. Besides this, no residuals are produced in the manufacture of water gas; and it must be admitted that this is a most serious drawback at a period when gas engineers the world over are expectantly looking for the coming of the good time when they can recover most, if not all, of the cost of manufacturing their gas by the sale of the residuals produced in the process.

The process of manufacturing water gas which I am about to introduce to you completely remedies these defects, by producing a water gas free from carbonic oxide, and at the same time residuals sufficient to repay the entire cost of manufacturing and distributing the gas twice over.

I shall now describe as briefly as I consistently can my process of making water gas, and at the same time producing ammonia and bi-carbonate of soda.

Let us first take a brief review of the state of the gas manufacture at present. First, we have the gas men who would gladly convert the carbonic oxide in their gas into carbonic acid, which

they could easily do without loss of volume, if it were not for the large volume of carbonic acid which they would be compelled to remove by lime, and which would consequently be a curse to them. They endeavor, consequently, to manufacture, as a basis for an illuminating gas, a water gas consisting as far as possible of hydrogen and carbonic oxide, and containing as small a percentage of carbonic acid as possible.

Next we have the manufacturing chemists who make cyanide of potassium and ammonia and who produce in the process immense volumes of carbonic oxide, carbonic acid, and hydrogen, and, for the most part, let these gases escape from their furnaces; and yet the gas men, as I have just stated, are erecting expensive works and expending large sums of money for the purpose of conducting a process the main object of which is to produce these waste gases of the manufacturing chemists.

And, again, we have the soda manufacturers, at least those of them who use the ammonia soda process, and whose number is constantly on the increase, who go to great expense to manufacture the carbonic acid which is the curse of the gas men, and which the chemists throw away; they at the same time buy ammonia from the gas men.

It will be readily seen how intimately these three industries are interlinked with and allied to each other, and how ridiculous it is that each of them should be throwing away as a nusiance just what the others are going to great trouble and expense to get; and I have no doubt that you will be greatly surprised to learn that the carbonic alone which may be produced in the water gas manufacture may be made to pay much more than the entire cost of making and distributing the gas, leaving the gas itself free, and with it many hundreds weight of ammonia for every ton of coal used.

I propose to produce, by a simple and continuous process, a water gas consisting of nearly pure hydrogen, and, simultaneously with it, large quantities of ammonia and bicarbonate of soda, the carbonic acid evolved in the process being combined in the latter salt, and becoming the most valuable product which I have, instead of being a curse as at present.

First. I make a cheap heating gas through the action of steam and air on incandescent carbon. This gas will contain so large a percentage of nitrogen as to be unfit for illuminating purposes. I call it "generator gas."

Second. I convert into ammonia the nitrogen of the generator gas produced in the first part of the process, or at least the greater part of it.

Third. I convert into carbonic acid all the carbonic oxide produced in the process, and replace it by an equal volume of pure hydrogen.

Fourth. I remove the carbonic acid from the gas by means of the ammonia produced in the second part of the process, producing bicarbonate of ammonia.

Fifth. I decompose the bicarbonate of ammonia formed in the fourth part of the process by means of chloride of sodium (common salt), producing chloride of ammonia and bicarbonate of soda.

I shall now describe each of the above five processes in detail, showing as I go its connection with those which have preceded it and those which are to follow.

In June, 1878, there appeared in the "American Gas Light Journal" the report of a lecture upon a new method of producing cheap heating gas for domestic and manufacturing purposes, delivered before the British Society of Arts by Mr. S. W. Davies, and the statements made were so very startling as to attract my attention strongly.

This gas was said to be obtained by the action of steam and air upon incandescent carbon contained in a close chamber or cupola, the action of which was continuous instead of being intermittent, as the ordinary process of making water gas is. The composition of the gas produced was about as follows :

Carbonic oxide	22.6	per cent.
Hydrogen	10.0	"
Light Carburetted hydrogen	4.9	"
Carbonic acid	4.5	"
Nitrogen	58 0	"
	100.0	per cent.

Mr. Davies' estimate was that ten pounds of anthracite coal were capable of producing 1,000 cubic feet of this gas, which would be at the rate of 224,000 cubic feet to the ton.

From some things which had come to my knowledge I was disposed to regard the above statements as considerably exaggerated. I could not help feeling, however, that if the yield of gas was anything like it was represented to be, and the nitrogen, or at least a very large percentage of it, could be eliminated from it, it would be the cheapest basis for an illuminating gas that the world had ever seen.

I paid little attention to the matter, however, until 1879, when a series of articles upon generator furnaces appeared in the "Journal of Gas Lighting," from which they were reprinted in the "American Gas Light Journal." These articles gave the results of a series of experiments which had been conducted during a period of more than two years by a committee of the German Gaslight Association; and the statements which they contained appeared deserving of the most implicit confidence, their correctness being vouched for by Grohn, Bunte, Schiele and Schilling, all engineers of the very highest standing.

These experiments showed that under suitable conditions an average result of one cubic meter of generator gas might be produced from 0.145 of a kilogramme of coke, or at the rate of 248,505 cubic feet of gas from one ton; its average composition being about as follows:

Hydrogen	13.70	per cent.
Carbonic acid	10.33	"
Carbonic oxide	17.33	"
Nitrogen	58.64	"
	100.00	

A reference to the diagram at *a* will show the formation of this generator gas, it being seen that the oxygen of the steam and air is set free and combined with the carbon to form carbonic oxide and carbonic acid, while the hydrogen of the steam and the nitrogen of the air are respectively set free.

It may not be amiss to state here the means by which I have arrived at the weight of coke and the products derived from it, as shown in the diagram.

Taking the German experiments as the basis of my calculations and dividing the 248,505 cubic feet of gas produced from a ton of coke, according to its component parts, I find the following results:

Hydrogen	13.70	per cent.=	34,045	cubic feet, and weighing	180 lbs.
Carbonic acid	10.33	" =	25,670	" "	3,013 "
Carbonic oxide	17 33	" =	43,105	" "	3,198 "
Nitrogen	58.64	" =	145,685	" "	10,854 "
	100.00	per cent=	248,505	cubic feet, and weighing	17,245 lbs.

Taking now the weight of nitrogen produced, 10,854 lbs., I find, by a simple calculation, $10,854 \times 12 \div 14 = 9,303$ lbs. as the weight of carbon which would be required for the complete conversion of this amount of nitrogen into cyanogen, and adding to this the weight of the coke already consumed in making the generator gas, I have $2,240 + 9,803 = 11,543$ lbs. $= 5,153$ tons of coke or carbon used in the entire process.

In order to find the entire product derived from one ton I now divide the entire weight of coke used, as well as the quantities and weights of the generator gas produced, and of its component gases, by 5,153 as a common divisor, and in this way arrive at the products given in the diagram, viz., 436 lbs. of coke used for making generator gas, and 1,804 lbs. used in converting the resulting nitrogen into cyanogen, &c.

In the case of the German, as well as of the English experiments heretofore mentioned, the large percentage of nitrogen present in the gas would evidently render it unfit for use for illuminating purposes; but, at the same time, it became obvious in both cases, that if this nitrogen could be removed, it would afford an extremely cheap basis for an illuminating gas.

Up to this time, like many of you I presume, I had paid but little attention to nitrogen or its compounds, and indeed felt no interest in it, looking upon it as an inert, unmanageable gas, which had little affinity for anything, and was of little account, at least so far as gas making was concerned.

I continued to think over the matter, and the more I reflected upon it the more I became convinced of the great value of any process by which I could eliminate nitrogen from generator gas produced by the action of air and steam upon incandescent carbon.

I commenced to study up the nitrogen question with a will, and for the next eighteen months devoted all my spare time to ascertaining the best means for eliminating it from generator gas. I rummaged the libraries for information, hunting up such old records and papers as I thought would assist me, and searching, often for weeks at a time, through the technical and scientific periodicals and the proceedings of learned societies, in the hope of finding something that would throw light upon the subject.

I was rewarded, since I found much more than I hoped for when I started out—but nothing connected; all I found consisted of mere fragments of intelligence and records of half tried and forgotten experiments scattered here and there through the patent and scientific records of the past forty years. The results of my searches, however, were to convince me that the only practicable plan of eliminating nitrogen from the gas was to convert it into ammonia. Well, as I have already stated, the second step in my process is to convert the nitrogen of the generator gas into ammonia.

When I started out to convert my nitrogen into ammonia, I had just a general idea of how to go about it. From the

authorities which I had consulted I made up my mind that the task was quite feasible; but, beyond a few general statements, I could find nothing to assist me for a long time, nor could I learn that ammonia had ever been produced upon a practical scale from the combination of atmospheric nitrogen with hydrogen.

I learned from "Wurtz's Dictionaire de Chimie," p. 484, that "nitrogen does not combine directly with hydrogen, but that it can unite itself with carbon at a red heat in the presence of an alkali or alkaline carbonate, and that it is a cyanide which is produced in this case." And again, p. 1171, that "the greater part of the cyanides—in a dry state—with the exception of those of mercury and copper, are pretty stable, and may be submitted to a red heat without decomposition, but in the presence of a little water produce carbonates and ammonia."

Again, p. 1075, that "when passed over carbonate of potassium heated to redness, cyanogen produces cyanide and cyanate of potassium; when the cooled mass is disolved in water, the latter salt becomes converted into alkaline carbonates and ammonia."

And again, p. 1084, that "cyanide of potassium is formed when a current of gaseous nitrogen is passed over the hydrate or the carbonate of potash heated to a red heat."

From Wurtz, and other authorities which is needless to quote here, I satisfied myself upon several points—

1st. That ammonia cannot be produced, at least upon a practical scale, by the direct synthesis of its elements hydrogen and nitrogen.

2d. That there is no difficulty whatever in evolving ammonia from cyanogen and its compounds.

3d. That alkaline cyanides are easily formed at high temperatures by the combination of hydrogen and carbon with an alkali or alkaline earth.

4th. That while a very high temperature is required for the production of alkaline cyanides, these same cyanides may be decomposed by steam at a temperature of 600° F., with the production of ammonia.

5th. That the ammonia so formed at a temperature of 600° is decomposed at a red heat, and that consequently the range of temperature between the points of formation and decomposition is extremely narrow.

I was confirmed in my conclusions as to the formation of cyanides by Sir Robert Kane, who says: "Cyanogen may, however, be formed abundantly, and in a simple manner, by

bringing its elements together at a high temperature in contact with substances with which it may unite itself. When any organic substance containing nitrogen is calcined with potash the nascent carbon and nitrogen unite, and cyanide of potassium is formed." And by Watts, who tells us ("Chemistry," vol. II., p. 203,) "that cyanides can be formed by passing atmospheric nitrogen over carbon impregnated with potash, has been sufficiently proved by several experiments, especially those of Havens and Bunsen (p. 198); and it has also been found possible to carry out this mode of formation on a manufacturing scale.

"Possoz and Boissiere first established a manufactory for this purpose at Grenelle, near Paris, in 1845, but subsequently transferred their operations to Newcastle, England, where fuel could be obtained at a much smaller cost. Their process, improved by Bramwell, of Newcastle, consisted in passing a current of air for ten hours over charcoal powder saturated with carbonate of potassium, and contained in wide earthen cylinders placed in an upright position.

"The factory was in operation for two years, during which it produced 1,000 kilogrammes (about a ton) of yellow prussiate daily. It was, however, not found to work profitably, and was ultimately abandoned, chiefly, it appears, on account of the large expenditure of fuel, and because the cylinders (retorts), whether of fire-clay or iron, were unable to stand the intense heat to which they were exposed."

Here was really something encouraging. Not only was the process of munufacturing ammonia by combination of its elements theoretically practicable, but I here found, upon the most indubitable authority, that cyanide of potassium, a recognized source of ammonia, had actually been manufactured upon a practical scale for a lengthened period, as I subsequently found confirmed by a paper read by M. Possoz himself before the French Academy of Science. (See "Bulletin de la Societe de l'Encouragement, and Comptes Rendus," for 1848.) I searched also for the French patents under which MM. Possoz and Boissiere started their operations in France, and was agreeably surprised to find in them more solid information upon the subject of manufacturing ammonia from atmospheric nitrogen than I had been able to derive from every other source combined; so much so that further investigation, as well as my own subsequent experiments, more than warrant me in pointing to these patents as a most reliable source of information upon the subject of manufacturing ammonia from atmos-

pheric nitrogen. They are No. 9,536, issued to MM. Possoz and Boissiere on December 24, 1843, and No. 1,183, issued to M. Possoz on October 1, 1845, and deserve the closest study and attention from any person interested in the subject either of manufacturing ammonia in the process of making water gas, as I propose to do, or of increasing the yield of ammonia in the process of manufacturing coal gas.

I have so far dwelt at length upon the various steps through which, without any previous knowledge upon the subject, I gradually studied out and formulated for myself a process for converting the nitrogen in the generator gas, produced in the first part of my process, into ammonia, partly with the idea that a plain statement such as I have made, and the references which I have given, would be of assistance to those who wish to investigate the subject for themselves, and partly with a view of satisfying you that what I have done in this matter has been the result of quiet and patient investigation.

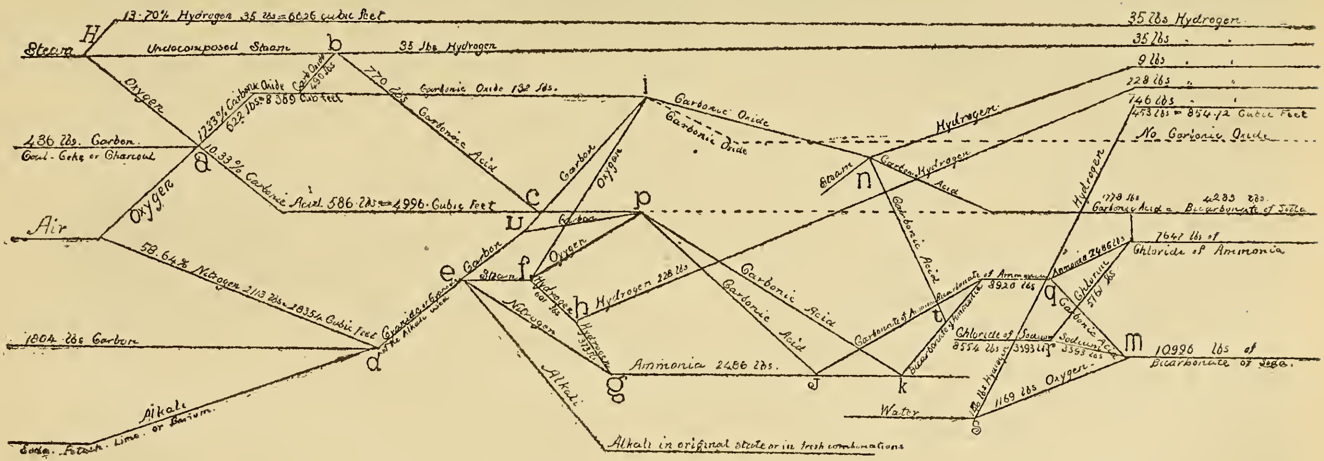
I am disposed to dwell upon the method of converting nitrogen into ammonia for the reason that this is the only part of my process which is at all strange to you, for the "American Gaslight Journal" has familiarized you all with the remaining parts thereof, and also for the further reason that this is the keystone of the whole process, and that consequently it is of importance that you should fully comprehend it. Indeed, the process of converting free nitrogen into ammonia, as I propose, is not by any means so strange or new as many of you would suppose, for it is merely a repetition upon a larger scale of the process by which all the ammonia produced in the manufacture of coal gas is obtained, with this difference, that where, even under the best conditions, you accidentally produce about 25 pounds of sulphate of ammonia from a ton of coal, I derive from the same ton of coal, and by the identical reactions which take place within your retorts, two hundred times as much.

It is well established that bituminous coal does not contain ammonia already formed, but that it does contain the elements of cyanogen and also of ammonia—a ton of coal usually containing from 50 to 75 pounds of nitrogen and a few pounds of alkalies, magnesia, lime, soda and potash. So much has been ascertained, although it is not well known in what shape exactly the nitrogen is combined in the coal. So that we have in the gas retort all the elements required for the production of cyanogen, the carbon, the nitrogen, and the alkali, all contained in the coal itself. And further, we have in the watery vapor which is continually given off during distillation, steam for the decomposition of the cyanogen and the formation of ammonia.

Is not this just the same as I do, except that instead of trusting to the 50 or 60 pounds of nitrogen and the few pounds of alkali contained in the coal for the production of ammonia, I furnish to and bring into intimate contact with the coal all the nitrogen and alkali necessary for its complete conversion into cyanogen, and which I afterward decompose by steam, with the production of ammonia?

Have you formed any idea of the quantity of ammonia that may be evolved out of the cyanogen produced from the carbon in one ton of coal, assuming the latter to be about 1,800 pounds? Why, about 2,500 pounds of ammoniacal gas, equivalent to the production of 9,705 pounds of commercial sulphate of ammonia. And it is only necessary to study, and to endeavor to reproduce as nearly as possible the reaction which takes place within your retorts to obtain a very large percentage of this. I do not pretend to tell you that you can get it all, but I have reason to believe that by good management it is possible to get at least one-third of it; and I need not tell you that if you get even the tenth or twentieth part of it you then have a big thing.

You may now tell me that this is all very well in theory, but that it is impossible to put it into practice. Have we not the most incontrovertible evidence that during a period of more than two years Mr. Bramwell successfully manufactured cyanide of potassium upon a large scale in England? And as evidence of the growing hold which the idea of producing ammonia by the synthesis of its elements has taken upon men's minds, have we not the fact, as already stated, that Mr. Young, of Clippens, has already succeeded in raising his yield of ammonia from 25 to 75 pounds per ton of coal, and is even now making improvements by which he expects to raise his yield to 112 pounds of ammonia and 50,000 cubic feet of water gas to the ton of coal. Nor does it look altogether like theory that Messrs. R. Dempster & Sons are even now erecting, at a cost of not less than £24,000, works in which ammonia will be the manufacture and gas the bye-product. Nor does it look mere theory to me that I have repeatedly tried the thing myself in a small and imperfect apparatus, where it was absolutely impossible to produce a sufficiently high heat or to maintain suitable conditions, and that I have repeatedly taken generator gas containing 60 per cent. of nitrogen, and after passing it through a small retort, have found this nitrogen reduced to less than 20 per cent.



Steam
H
13·70% Hydrogen 35 lbs = 6626 cubic feet
Undecomposed Steam
b
35 lbs Hydrogen
770 lbs
Carbonic Oxide 132 lbs.
Carbonic Acid
436 lbs. Carbon.
Coal · Coke or Charcoal
Oxygen
a
12·33% Carbonic Oxide
622 lbs = 8 369 Cub feet
10·33% Carbonic Acid 586 lbs = 4996 Cubic Feet
Air
58·64% Nitrogen 2113 lbs = 1835½ Cubic Feet
1804 lbs Carbon
d
Alkali
Soda · Potash · Lime · or Barium.
e
Carbon
c
u
f
Steam
Oxygen
p
h
Hydrogen 228 lbs
Nitrogen
Alkali
g
Ammonia 2486 lbs.
Alkali in original state or in fresh combinations
i
Carbonic Oxide
Garbonic Oxide
Garbonic Acid
Carbonic Acid
Hydrogen.
n
Steam
Carbon Hydrogen
Acid
Carbonic Acid
j
k
t
Carbonate of Ammonia
Bicarbonate of Ammonia
8920 lbs
q
Chloride of Sodium
8554 lbs
3393 lbs
Sodium
3393 lbs
Carbonic Acid
Chlorine
5161 lbs
Ammonia 2486 lbs
Hydrogen
Water
s
1169 lbs Oxygen
m
35 lbs Hydrogen.
35 lbs
9 lbs
228 lbs
746 lbs
453 lbs = 854·12 Cubic Feet
No Carbonic Oxide
1778 lbs
Carbonic Acid = Bicarbonate of Soda
4283 lbs.
7647 lbs of
Chloride of Ammonia
10996 lbs of
Bicarbonate of Soda.

Is it anything more wonderful that ammonia should be produced by the synthesis of its elements than that beef fat should be chemically changed into butter, or that grape sugar should be artificially produced? Is it any more wonderful than the telephone? And yet any person who would have dared ten years ago even to hint that it was possible to converse with a friend twenty miles away would have been laughed at as an idiot. And, for all that, some how or other all these things have come to pass, and are now such old stories that even the children have ceased to wonder at them.

One thing is certain: the foremost men in the profession unhesitatingly declare that the day is not far distant when gas will be the residual product. The idea is daily growing and taking a stronger hold on men's minds; and the experience of the world is that, whenever the leading men in any business or profession have unanimously fixed their minds upon a certain objective point, then some of them are sure to reach it within a little while. And never in the history of gas-lighting have men's minds been directed more earnestly than they are now to the best means of obtaining an increased yield of ammonia.

In this respect it may be well worth our while to consider whether it would not pay those of you who are engaged in the manufacture of coal gas to follow the lead of your English brethren, and to endeavor, as they are doing, to increase your yield of ammonia according to the system of Mr. Young, whose efforts in this direction have been attended with the most unqualified success; which may be well believed when we are assured, upon excellent authority, that the ammonia produced, even in the best conducted works, ranges from one-sixth to one-tenth of what may be obtained from the nitrogen contained in the coal, on which subject Lunge, in his late work on the distillation of coal tar and ammoniacal liquor, states, upon the authority of Dr. C. Maymoth Tidy, and also, I think, of the late Dr. Letheby, that the nitrogen contained in various samples of coal examined by him was capable of producing from 142 to 226 gallons of ammoniacal liquor of 4 degrees Twaddle per ton of coal, whereas, instead of this possible yield, rarely more than 45 gallons of gas liquor, of 4 degrees Twaddle, is obtained per ton of coal—usually 25, in London only 13 gallons.

The reactions by which cyanogen is produced, and is afterward converted into ammonia with the production of additional volumes of carbonic acid and hydrogen, are shown upon the diagram by the letters *d*, *e*, *i*, *u*, *p*, *e*, *f*, *h*, and *g*.

I should here state that before proceeding to the third part of my process, which involves the subjection of the gas to such a heat as would be destructive to my ammonia—this gas being decomposed and resolved into its elements at a red heat—I pass the gas through suitable condensers and scrubbers, in the latter of which my ammonia combines with the carbonic acid in the gas to form soluble carbonates of ammonia, which escape from the scrubbers as ammoniacal liquor.

The third part of my process relates to the conversion of the carbonic oxide in the gas into carbonic acid, with the liberation of a volume of hydrogen equal to that of the carbonic oxide removed.

I effect this by causing the carbonic oxide to decompose incandescent steam, which it readily does, combining with the oxygen of the steam to form carbonic acid, and liberating its hydrogen; the volumes of the carbonic acid produced, and of the liberated hydrogen, being in all cases each equal to that of the carbonic oxide removed; so that it will be perceived that there is no loss of gas in the process, but on the contrary a large increase, the carbonic oxide being replaced by an equal volume of hydrogen, and at the same time converted into a similar quantity of carbonic acid. There is nothing new or experimental in all this, for it was all done at Narbonne, in France, as far back as 1854, when Fayes succeeded in constructing an apparatus in which water gas practically free from carbonic oxide was made upon a practical scale for several years. (See historical notice of lighting by water gas in "La Genie Industriel," Vol. II., p. 148. See also Vol. XVII., p. 1,) where you will find the following analysis of the water gas produced at Narbonne:

Watery vapor	3	per cent.
Carbonic acid	3	"
Carbonic oxide	2	"
Carburetted hydrogen	1	"
Hydrogen	89	"
Loss	2	"
	100	

Verver's analysis states the composition of the Narbonne water gas to have been as follows:

Watery vapor	1.02	per cent.
Carbonic acid	.50	"
Carbonic oxide	3.54	"
Light carburetted hydrogen	.38	"
Hydrogen	94.08	"
Nitrogen	.12	"
Loss	.36	"
	100.00	

For a full report on this gas see "Journal fur Gasbeleuchtung" for 1859, page 372, and 1861, page 90.

Indeed, it is well known that the manufacturers of water gas would gladly avail themselves of the process just described of removing all the carbonic oxide from their gas and replacing it by an equal volume of pure hydrogen, were it not for the enormous quantity of carbonic oxide produced, and which they would subsequently be compelled to absorb by lime, the great expense of which naturally deters them.

Just imagine the quantity of lime required for the absorption of the carbonic acid produced by the complete combustion of one ton of carbon. $2240 \times 22 \div 6 = 8{,}213$ pounds, which, multiplied by 8.52, gives 69,973 cubic feet of carbonic acid as the product of the perfect combustion of one ton of carbon.

Now, a pound of lime cannot absorb more than 6 cubic feet of carbonic acid, and consequently we have $69{,}974 \div 6 = 11{,}662$ pounds of lime as the quantity required for the complete absorption of the carbonic acid produced by the perfect combustion of one ton of carbon, which is manifestly too much of a good thing.

While there is nothing new or experimental in the simple conversion of carbonic oxide into carbonic acid, with the liberation of an equal volume of hydrogen, there is most decided novelty in the process of first making ammonia with which to remove the enormous volume of carbonic acid produced in the process, and in subsequently converting the latter into a valuable product, as will be presently seen.

The reaction whereby the carbonic oxide of the gas is converted into carbonic acid, with the liberation of an equal volume of hydrogen, is shown upon the diagram by the letter *n*.

The fourth part of my process relates to the purification of the gas from carbonic acid by means of the ammonia produced in the process itself—the ammonia and carbonic acid being caused to combine and to form soluble carbonates of ammonia.

There is little necessity for me to say to you that there is nothing new in absorbing carbonic acid by means of ammoniacal liquor, for this is well knewn to gas men, the principle of the process being that, when a gaseous mixture containing ammonia and carbonic acid is caused to pass in a cool state through wet scrubbers, these gases combine, the ammonia being compelled to absorb a double equivalent of carbonic acid, so that there is no difficulty in relieving gas from this impurity by means of ammonia when even a half equivalent of the latter gas is present, and even very

much less than this quantity may be made to serve for the complete purification of the gas from carbonic acid, by having recourse to the well known principle of regenerating or recovering the ammonia at the end of the process, which may be easily effected by boiling the chloride produced in the fifth and last part of the process with milk of lime, as practiced in the ammonia-soda process, where the same ammonia, less five per cent. loss each time, is used over and over again all the while.

On the subject of ammoniacal purification of gas, I would refer you to the "American Gas Light Journal" Vol. XVII., pages 24 and 118, and Vol. XXVII., page 175. Also see page 178, same volume, where Mr Livesey uses these words: "The great thing to be desired is more ammonia." And again, same page, where Mr. Hunt says: "There is nothing really new in Messrs. Wallace and Claus' process in regard to the carbonic acid, but simply with regard to the supply of ammonia—there was the dificulty." And again, on page 179 you will find Mr. Livesey saying: "There was the fact that they had not nearly enough ammonia to purify the gas."

So you see that there is nothing very strange or experimental in my proposition to purify my gas from carbonic acid by means of ammonia, and that the great novelty consists in providing ammonia enough to do the work.

The purification of the gas from carbonic acid by means of the ammonia in the gas itself, with the formation of bicarbonate of ammonia, is shown upon the diagram by the letters *j*, *k*, and *t*.

It may be observed, at the same time, that the carbonic acid which enters into combination with ammonia, as shown at *j* and *k*, is insufficient for the conversion of the entire ammonia into bicarbonate, and that the additional volume of carbonic acid produced from the carbonic oxide, as shown upon the diagram at *n*, not only supplies this deficiency as shown at *t*, but in addition thereto, leaves an excess of 1,778 pounds of carbonic acid to be afterward treated by regenerated ammonia, as already described.

The fifth part of my process consists of the decomposition of the bicarbonate of ammonia produced in the fourth part of the process, by means of chloride of sodium (common salt), with the production of chloride of ammonia and bicarbonate of soda.

It cannot be said that there is anything new or experimental in this, as it is nothing more or less than the ammonia-soda process, which is now so well known, and which is carried on most successfully, upon a large scale, in many places in Belgium and

England. (See Lunge, on "The Manufacture of Sulphuric Acid and Alkalies," Vol. III." p. 33.) There you will find that, in 1878, M. Solvay, a Belgian manufacturer, produced 50,000 tons of soda of a superior quality by this process. Also, if you will refer to the Report (part 1., p. 180) for 1880, of the Iron and Steel Institute, you will find that the same Solvay finds his business of making soda by this process so very profitable that he can afford to transport ammoniacal liquor 300 miles by rail for use in the manufacture of soda. In addition to purchasing ammoniacal liquor for use in the soda manufacture and hauling it 300 miles over railways, M. Solvay manufactures carbonic acid for use in the process; and, on account of the difficulty of procuring ammonia at a reasonable price, is now, as I am informed, beginning to manufacture it himself.

The most attractive feature of the soda-ammonia process, as used in conjunction with mine, is that so far from finding my carbonic acid a curse and a source of expense, I, by this means, convert it into the most valuable product I have, inasmuch as I am thereby enabled to transform two pounds of rock salt, worth less than one cent, into one pound of bicarbonate of soda worth five cents, an operation which, owing to the great quantities produced will of itself more than repay the entire cost of making and distributing the gas, leaving the ammonia and gas itself free.

The reaction which takes place between the bicarbonate of ammonia and the chloride of sodium, as just described, are shown upon the diagram by the letters *q*, *r*, *l* and *m*.

I have shown upon the diagram the weight and volume of the various products capable of being obtained as ultimate results from the perfect conversion of the material used, basing my calculations upon the well known equivalents of the various bodies involved in the reactions produced.

It must not be supposed from this that I believe myself, or would have you believe, that the results as given, or anything like them, can be obtained in practice; but the ultimate results of perfect reaction in the several parts, and of the perfect conversion and utilization of one ton of coal and 8,554 lbs. of rock salt, as calculated from the chemical equivalents of these bodies, would be as follows:

85,472 cubic feet of hydrogen, worth 25 cents	$21.36
15,289 lbs. bicarb. soda, worth, 5 cents	763.95
7,647 lbs. chloride of ammonia, worth 5 cents	382.35
	$1,167.66

These figures may well startle and astonish you as I confess they startled and astonished me when I first attempted to formulate the chemical reactions of the process, as shown upon the diagram, and to calculate the results and products; but as I have already said I have no expectation, nor is there the slightest hope that these results, or anything like them, can ever be attained in practice. There is, however, excellent reason to suppose that at least one-third, perhaps one-half, of the ultimate results can be reached in time; for the experience of the world proves that whenever men become convinced that a valuable prize is within the possibilities they find some means of obtaining it.

It will be perceived that in estimating the ultimate results of one ton of coal or coke I have made no allowance whatever for the fuel used in the producing reactions which require that large volumes of gas should be heated and cooled twice over and, in addition thereto, that great quantities of ammoniacal products should be crystallized from their solutions by heat.

It is proposed to use the generator gas itself for fuel, and I think that half of this will be a liberal allowance for that purpose, which would reduce the products obtained to one-half the above quantities, so that we would have, as the product of one ton of coal or coke and 4,277 lbs. of coarse salt, the following products:

42,736 cubic ft. of hydrogen, at 25 cents per 1,000	$10.68
7,644 lbs. bicarb. soda, at 5 cents per lb	382.20
3,823 lbs. chloride of ammonia, at 5 cents per lb	191.15
	$584.03

You may now with justice ask—what reason have you for the faith that is in you when you tell us that there is excellent ground for hope to suppose that certainly one-third, and possibly one-half of these enormous products can be obtained at the cost of one ton of coal and 4,277 lbs. of coarse salt, plus the cost of labor?

Careful investigation of the methods pursued in former times to produce ammonia from atmospheric nitrogen leads irresistibly to the conclusion that they were wasteful and extravagant, for the first efforts in this direction were confined altogether to the practice of producing the required reactions by the application of heat to close retorts containing the material operated on. We learn, however, from M. Possoz, that all attempts in this direction were failures. To use his own words:

"In order to heat the entire mass (of carbon and alkali) to the point necessary to the production of cyanogen, it became

necessary to heat the retort externally to such a point that in a little while it became full of holes or cracks, or otherwise useless; and, finally, in practice it was found impossible to heat uniformly a mass the center of which was always cooler than the sides, for the white heat had to traverse not only the thickness of the wall of the retort, but moreover the thickness of the alkalized carbon between the sides and the center, so that in order to obtain the proper heat in the interior it was necessary to regulate the introduction of alkalized carbon to the retort very carefully (he used a vertical retort and continuous feed) because if the quantity introduced was too great in proportion to the heat very little cyanogen was got."

He found also that it took fifteen days to get a working heat upon his retorts, and that they frequently gave out in a week or two.

Moreover he used gas in a cold state, for he further says, "I was obliged to force through this mass (of incandescent carbon and alkali) a current of gas the temperature of which was always much less than that necessary for the production of alkaline cyanides, and the interior of the mass, that it cost so much trouble to heat, was thereby being continually cooled."

You will easily perceive that the cause of failure here was in the attempt to heat a dense mass of fine carbon and alkali contained in a vertical retort, where it had every chance to pack itself, by external heat, and at the same time force a large volume of cold nitrogen gas through it; moreover, the retorts soon became leaky, and consequently, owing to the high pressure used for the purpose of forcing the gas through the dense mass of carbon and alkali in the retort, a great part of the gas passing through it was lost.

It will be seen that the failure here was altogether owing to defects in the construction and management of the retorts used, and not at all to anything in the process itself.

M. Possoz soon removed these difficulties, at least in a measure, by heating the nitrogenous gases destined for the production of the cyanogen to incandescence before admitting them to the furnace. He found such good results from the change that he soon learned to place his chief reliance upon the heating effect of the incandescent nitrogenous gas passing through the furnace for the production of cyanides, and to expect from the external fires little more than the retention of heat in the retort and fire-bricks around it.

This was the principle of heating adopted by Mr. Bramwell, of Newcastle, who, as has already been said, made a ton of

cyanide of potassium daily for a period of more than two years. The business, as before stated, was found not to be profitable, and was finally abandoned. It must, however, be remembered in this connection that he threw away all his carbonic acid and heating gases.

It is strange that with all this experience upon record, and easily accessible to any person who would take the trouble to hunt it up, out of more than twenty English patents that I have consulted for the manufacture of ammonia all but two are based upon the principle of external firing, abandoned so long ago by Possoz, and that these two are the only ones which have hitherto given the slightest promise of successful development.

The wonderful state of perfection to which the system of superheating gases has been brought, in consequence of the introduction of the Siemens and other heating furnaces, and the equally wonderful results obtained in the combustion of pulverized fuel, and in the system of converting it into heating gas by means of superheated steam, as first introduced by Crutchett in 1865, and since brought to a high state of development by Strong, Dwight and others, appears to me to afford the true solution of the difficulties which have attended the earliest attempts to produce ammonia artificially from atmospheric nitrogen.

You are all aware that in what is known as the strong system of making water gas steam is raised to a most intense temperature, by being caused to pass through a cupola containing a reticulated mass of fire-brick, previously raised to a white heat, and that the steam being thus raised to a high temperature, in passing through and in contact with the heated bricks, is caused to meet a falling shower of coal dust, which is automatically and continuously fed into the cupola, the effect of which is that the coal dust instantaneously, I should almost say explosively, decomposes the steam, producing carbonic oxide, carbonic acid, and free hydrogen. Experience proves that the gasification of the coal dust is much more perfect than when lump coals is used, and further, that it proceeds with three times the rapidity. The same principle is also successfully applied to the desulphurization of gold and silver ores.

A little reflection will show what a perfect analogy there is between the oxidation of pulverized coal by the oxygen of incandescent steam and the cyanization of pulverized coal and alkali by the nitrogen in incandescent nitrogenous gas, and that the

system which has been applied with such marked success in the manufacture of gas should produce equally good results in the production of cyanogen and alkaline cyanides.

Upon this head there is excellent reason to believe that the splendid results produced by the gasification of pulverized fuel by incandescent steam are but a tithe of what may be expected from the application of the same principle to the manufacture of alkaline cyanides as a step in the manufacture of ammonia.

As far as I have been able to inform myself, the greatest difficulty experienced by Bramwell was the caking or solidification of the mixed coal and alkali in his furnaces; and indeed my own experience has satisfied me that, under the ordinary conditions of practical work, it would be impossible to operate successfully upon a mixture of lump coal and alkali in an upright cupola or retort for the production of cyanogen; for when the alkali used is lime or salt, or a mixture of both, which, for economical reasons, will be found most suitable, it will settle down into the lower part of the furnace and actually choke it up, a defect which Bramwell attempted to remedy by surrounding his cupola with slots through which he could break up the compact mass within it.

As to the alkali best adapted to the production of ammonia and heating gas, I am satisfied that lime mixed with a little salt or slaked with a strong solution of salt will be found by far the most economical, and equally as effective as any other. It is true that nearly all the authorities upon the manufacture of cyanides from atmospheric nitrogen point to potash as the most suitable alkali for the purpose. But it must be remembered that, in all the former experiments in this direction, the object was the production of ferrocyanide of potassium, the reason of which was not that potassium was more suited for the production of cyanides than some of the other alkalies, but that most of the cyanides are very unstable and decompose very rapidly, while, on the contrary, ferrocyanide of potassium is very stable, on which account it has been looked upon as a most desirable combination in which to fix nitrogen.

I fear that I have already trespassed too much upon your valuable time, and feel that I owe you an apology therefor; but having devoted much time and experiment to the investigation of a process which, in many of its aspects, is entirely new, and the principles of which are in the closest union and accord with the ideas of the most advanced thinkers of the profession, I have been induced to enter into particulars perhaps more fully than

was actually necessary, but not more so than is due to the importance of a subject which appears to engross a very large share of attention, especially in view of the competition of electricity and petroleum—chiefly the latter, and of the enormously increased consumption of gas which would be sure to follow such a marked reduction in the selling price as the adoption of this process would lead to.

If, however, I have succeeded in directing your thoughts into a new channel the attention which you have given me will, I hope, not be altogether devoid of fruit; for a germ, even of error, which is started into life frequently ripens into a rich and abundant harvest of truth and progress.

In the hope, then, that my effort may not be altogether unprofitable to you, and thanking you for your kind attention, I would close by asking for a calm consideration of the statements which I have made, and by again reminding you, in the words of Mr. Clegg, that "He is a bold man who, at the present day, condemns a new thing without very deliberate consideration, and he is an imprudent one if he accepts for truth anything that is advanced in favor of a new thing without the same precaution."

DISCUSSION.

The President—I have no doubt that a majority of our members have followed Mr. Fogarty through his very comprehensive description of his new process; but if there are any gentlemen present who do not clearly comprehend it in its details, Mr. Fogarty will answer any questions which may be propounded.

Mr. Harbison—I have been very greatly interested in the able paper which has been read, but not fully comprehending all the points raised by Mr. Fogarty, I desire to inquire of him where this new process is in practical operation, in order that I may see it. I consider this a matter of very great importance. Thus far I have not given very much attention to the manufacture of ammonia and common salt, because I trusted to my friend, Wood, in the neighborhood, to supply me. I would like to know where I can see the results which Mr. Fogarty describes.

Mr. Fogarty—It has not yet been tried upon a practical scale, but it is about to be tested. Arrangements are now being made for the purpose of testing it upon a practical scale. It has, however, been examined by some of the best chemists in the country.

Mr. Harbison—May I inquire where it has been tested?

Mr. Fogarty—Come to me at any time after the meeting, and I will tell you all about it.

Mr. Harbison—I desire a statement for general information. Where is it being tested?

Mr. Fogarty—It is being tested in Baltimore.

Mr. Harbison—I was in hopes we would find out from the paper just what we could get for these residual products, and what it would cost to manufacture the gas by the process described by Mr. Fogarty. I do not understand him to give any definite figures, or else I have overlooked them in the reading.

Mr. Fogarty—I gave the figures as to the results of the whole process, and as to the material used—that is to say, one ton of coal and 4,277 pounds of common salt.

Mr. Harbison—How much per thousand will the gas cost in the holder?

Mr. Fogarty—I figured up the values and gave the detailed results; and anybody can figure the rest for himself.

Mr. Harbison—You do not state exactly how much it will cost per thousand.

Mr. Fogarty—No; not fully. I think the labor would be about twice what it is in the ordinary water gas process. Probably the labor would be 7 cents per thousand. I find the ultimate result, which is all I have attempted to give here, to be: From one ton of coal or coke and 4,277 pounds of coarse salt, 42,736 cubic feet of hydrogen gas, worth 25 cents per thousand, which would be $10.68.

The President—Mr. Harbison desires to get at the cost of placing 1,000 cubic feet of hydrogen gas in the holder.

Mr. Fogarty—I cannot state that distinctly. I have calculated the ultimate products of the reactions of one ton of coal. I cannot state, without having tried the whole thing on a practical scale, to what extent these products can be realized in practice; but this is the ultimate product.

Mr. Harbison—Can Mr. Fogarty give us any idea whether we shall be able to see this process in practical operation at any time during the next twelve months? Or will he be able to tell us a year from this time what the cost will be?

Mr. Fogarty—Probably within three months.

Mr. Harbison—That is quite important to those who are remodeling their works.

Mr. Fogarty—Probably it will be in full working order inside of three months. The theoretical product would be: From one

ton of coal and 4,277 pounds of coarse salt (which would be worth about $40) $584 worth of products. There is nothing more certain than that that amount of material can be evolved from a ton of carbon, and in the reaction which follows it; and it is equally certain that whenever men make up their minds that there is that much there they will probably find a way of getting a good share of it. If they can succeed in getting one-sixth part of it they will get a good thing.

Mr. Forstall—Can you give us any idea as to what the cost of the plant would be?

Mr. Fogarty—Not yet; but so far as the cost of the gas making is concerned, it would be but very little more expensive than the plant of the present water gas. The ammonium-soda process, which will follow it, is not so expensive. It is not an expensive plant, because the greater part of the apparatus is composed of wooden tanks lined with metal.

Mr. Forstall—Bnt you have no idea what capital outlay would be required to make a million feet of gas?

Mr. Fogarty—No; I have not got at that yet.

Mr. Forstall—I understood you to say that the cost of your gas would be about 75 cents less than nothing. That would be an answer to Mr. Harbison's question.

Mr. Fogarty—That is what I believe—that it will be 75 cents per thousand feet less than nothing.

Mr. Harbison—That will enable me to sell gas at a very low figure and still pay respectable dividends to my stockholders; and we would be very sure in that case of having the moral sympathy of every consumer in Hartford. [Laughter.]

The President—There are present with us to-day two distinguished engineers—one distinguished as possessing an intimate knowledge of the uses and value of hydrogen gas for heating purposes, and the other mainly distinguished because of his knowledge of the value of residual products. I refer to Messrs. Goodwin and Page. These two gentlemen would probably be able to extract from this subject the information which the members are so desirous of obtaining in detail, as to the cost and practical results of the new process.

Mr. Goodwin—This seems to be so clearly a case of residual products that it is quite out of my line of investigation; but Mr. Page can discuss that subject with you, and can give you, doubtless, all the information you desire.

Mr. Harbison—I will cheerfully resign the further cross-examination of Mr. Fogarty in favor of the senior counsel, Mr. Page.

Mr. Page—I was about to ask Mr. Fogarty one or two questions. It seems that one of the chief results of this new process is the bicarbonate of ammonia by the soda-ammonium process. I presume that, with all the information which Mr. Fogarty has shown us he posesses upon this subject he is also aware of the fact that the Solvays hold a patent for the soda-ammonium process in the United States. I had an interview with them at their residence in Brussels, about three months ago. They confirmed what I had learned before from Mr. Cogswell, of Syracuse (whom my friend Mr. Wood knows intimately), that works are being constructed at Syracuse for the making of soda by the soda-ammonium process; but I am very sure, from my knowledge of the matter, that it would be impossible for this company, or any other, to upset their patents. A convention of chemical manufacturers was held, while I was in England, to discuss the imminent peril which their trade was experiencing from these newer and cheaper processes of making soda. It was admitted that the cheapness with which it could be produced by the use of ammonia was such that, unless they could find some cheaper way than that which has brought so much of profit to Newcastle, Glasgow, and other manufacturing centres, the manufacture of soda would be lost to them. But, thus far, no chemist has devised any cheaper way of producing soda. I am sure that gas managers will be glad to learn that the manufacture has been fairly inaugurated on this side of the water. As yet we cannot compete with Newcastle and Glasgow; but we have reason to believe that in the near future the gas industry will furnish the means by which a successful competition may be carried on. Possibly our friend Mr. Fogarty, who is able to produce such enormous quantities of ammonia, will find a cheaper process for obtaining it than from the ammoniacal liquor. It is a pertinent fact to bring forward in connection with the paper which has just been read, and as illustrating the value of the process which has been shown, that the Solvays inform me they are transporting ammoniacal liquor from Holland to Marseilles in tank cars, and are using it in their process for making a cheaper alkali. That demand has advanced, to some extent, the value of ammoniacal liquor on the Continent; and the increase has been very considerable in England, Ireland, and Scotland during the past year, because of the other purposes for which it is used—mainly the making of sulphate of ammonia for fer-

tilizing purposes. A demand exists for every pound which can be produced. Yet here in the United States perhaps not over 30 gas companies, out of 700 or 800, received anything for their ammoniacal liquor. Even our friend Mr. Pratt, of Jamaica Plain, would be able to reduce his gas below $2.50 if he utilized his ammoniacal liquor, converting it, as he could economically with his present carbonization, into sulphate of ammonia, and realizing at its present average price ($4\frac{1}{2}$ cents per pound), for 25 pounds out of each ton of coal, something in the neighborhood of $2,000 per annum. Were he to do this he would have a still stronger claim upon the moral "support of the community." [Laughter.] But I must not occupy more of your time. I wish I had the scientific knowledge to which your President has so complimentarily referred, so as to be able to understand fully the process which has been presented by Mr. Fogarty. I can only urge upon every one carbonizing even 500 tons of coal per annum the great importance of saving the ammoniacal liquor and making it valuable by proper concentration. I could read you many interesting extracts from their annual reports, showing the advance in the amount received for the ammoniacal liquor and the sulphate of ammonia by scores of English, Scotch, and Irish gas companies—many of them being able to buy their coal with the money received from their residuals. With the fading away of the guano deposits, and the higher price of other sources of ammonia, it must be obtained from the ammoniacal liquor produced by carbonizing bituminous coal, as the water or naphtha gas processes cannot produce it.

Mr. Fogarty—Have you ever looked over Henning & Dyer's patents?

Mr. Page—I do not think I have.

Mr. Fogarty—I can show you that the Solvays have no claim whatever to the soda-ammonia process. It is free to all. The process was first developed and patented in England in 1838, by Henning & Dyer and Grey and Harris, and had been successfully tried by several manufacturers long before the Messrs. Solvay dreamed of it, while Solvay's patent was taken out in 1863. Tuerk, and also Schloesing and Rolland had taken out patents as early as 1854. Works had been started near Paris in 1855, under Schloesing and Rolland's patent, and Mickles carried on the manufacture of soda under Tuerk's patent, improved by him at the works of Lorraine, from 1865 to 1867, about which time Solvay took it up. Solvay has an absolute claim upon

certain improved methods of carrying it out; that is all. The process itself is free to all. I have the patents here, and you are welcome to see them if you wish.

Mr. Page—If that process were open to the public, the wealthy chemical alkali manufacturers of Newcastle and Glasgow would have adopted it long ago.

Mr. Fogarty—It may be that the Solvays have a right to the most improved processes and methods of carrying out the process; but the process itself is absolutely open, as I can prove to you. I do not say anything that I cannot give chapter and verse for.

Mr. Greenough—I wish to ask Mr. Fogarty as to the working of a matter of detail which I do not understand. I noticed that he says in his paper, as to the second part of the process, that he proposes to pass the gas from the generator through a Siemens superheater, heated to as high a temperature as can be practically done, by the combustion of a part of the generator gas itself. Do you mean to burn a part of the gas in the chamber and heat the rest of it at the same time?

Mr. Fogarty—I mean that the superheater is double, and that while you are heating one side of it by the combustion of part of your generator gas, another portion of the same gas is being superheated in the other side of the generator, the operations of both sides of which are reversed from time to time.

Mr. Greenough—Do you burn half of it?

Mr. Fogarty—I expect that it will take half of the generator gas to do the work.

Mr. Greenough—Can you pass the other half unconsumed through the generator?

Mr. Fogarty—Certainly.

On motion of Mr. Harbison the thanks of the Association were tendered to Mr. Fogarty for his carefully prepared and comprehensive discussion of the new process of manufacturing gas and residual products.

APPENDIX D. PAPER 1.

[Revised Statutes of New Jersey, page 460, 1877.]

An Act to authorize the formation of gaslight corporations and regulate the same. Approved, April 21, 1876.

1. That any number of persons, not less than thirteen, may form a company for the purpose of constructing, maintaining and operating gas works, and for that purpose may make and sign articles of association, in which shall be stated the name of the

company, the number of years the same is to continue, the village, town, or city in which it is proposed to supply and distribute illuminating gas, construct, maintain, and operate the works. the amount of the capital stock of the company, and the number of shares of which said capital stock shall consist, and the names and places of residence of thirteen directors of the company, all of whom shall be residents of this State, and two-thirds, at least, of whom shall be residents in the particular place where the works are to be erected, who shall manage its affairs for the first year and until others are chosen in their places; each subscriber to such articles of association shall subscribe thereto his name, place of residence, and the number of shares of stock he agrees to take in said company, on compliance with the provisions of the next section, such articles of association shall be filed in the office of the Secretary of State, who shall indorse thereon the day they are filed, and record the same in a book to be provided by him for that purpose; and upon tendering the said articles to the Secretary of State to be filed, the persons who have so subscribed such articles of association, and all persons who shall become stockholders in such company, shall be a corporation by the name specified in such articles of association.

2. That such articles of association shall not be filed and recorded in the office of the Secretary of State until at least one-half the amount of the entire capital stock is subscribed thereto, and twenty per centum paid thereon, in good faith, and in cash, to the directors named in said articles of association, nor until there is indorsed thereon, or annexed thereto, an affidavit, made by at least seven of the directors named in said articles, that the amount of stock required by this section has been in good faith subscribed, and twenty per centum paid in cash thereon, as aforesaid, and that it is intended in good faith to erect gas works and manufacture and sell gas to the city, village or town, as specified in the articles of association, which affidavit shall be recorded with the articles of association as aforesaid.

3. That a copy of any article of association filed and recorded in pursuance of this act, or of the record thereof, with a copy of the affidavit aforesaid indorsed thereon or annexed thereto, and certified to be a copy by the Secretary of this State, shall be presumptive evidence of the incorporation of such company, and of the facts therein stated.

4. That when such articles of association and affidavit are filed and recorded in the office of the Secretary of State, the directors named in such articles of association may, in case the whole of the capital stock is not before subscribed, continue to receive subscriptions until the whole capital stock is subscribed. The capital stock of any corporation organized under this act shall not be less than five thousand dollars for every one thousand of the population of the village, town or city in which it is proposed to erect the works or to lay pipes in order to supply said village, town or city with illuminating gas, the number of the population to be taken from the latest census of the population, whether the same was made by the general or State government. At the time of subscribing, every subscriber shall pay to the directors twenty per centum on the amount subscribed by him, in money, and no subscriptions shall be received or taken without such payment.

5. That there shall be a board of thirteen directors of every corporation formed under this act, to manage its affairs; said directors shall be chosen annually by a majority of the votes of the stockholders voting at such election, in such manner as may be prescribed in the by-laws of the corporation, and they may and shall continue to be directors until others are elected in their places. In the election of directors each stockholder shall be entitled to one vote for each share of stock held by him; vacancies in the board of directors shall be filled in such manner as shall be prescribed by the by-laws of the corporation; the inspectors of the first election of directors shall be appointed by the board of directors named in the articles of association. No person shall be a director unless he shall be a stockholder, owning stock absolutely in his own right, and qualified to vote for directors at the election at which he shall be chosen. At every election of directors the books and papers of such company shall be exhibited to the meeting, *provided* a majority of the stockholders present shall require it.

6. That the directors shall appoint one of their number president, they may also appoint a treasurer and secretary, and such other officers and agents as shall be prescribed by the by-laws, and shall establish and fix such salaries to them and to the president as to said board of directors shall appear proper.

7. That the directors may require the subscribers to the capital stock of the company to pay the amount by them respectively subscribed, in such manner and in such instalments as they may deem proper. If any stockholder shall neglect to pay

any instalment as required by a resolution of the board of directors, the said board shall be authorized to declare his stock, and all previous payments thereon, forfeited for the use of the company, but they shall not declare it so forfeited until they shall have caused a notice in writing to be served on him personally, or by depositing the same in the post office, properly directed to him at the post office nearest his usual place of residence, stating that he is required to make such payments at the time and place specified in said notice; and that if he fails to make the same his stock and all previous payments thereon will be forfeited for the use of the company, which notice shall be served as aforesaid, at least thirty days previous to the day on which such payment is required to be made, *provided*, that if said company shall not declare such stock forfeited, then such neglecting stockholder shall be individually liable to said company for the amount unpaid upon the stock so held by him, until the whole amount of the capital stock so held by him shall have been paid to the company.

8. That the stock of every company formed under this act shall be deemed personal estate, and be transferable in the manner prescribed by the by-laws of the company, but no shares shall be transferable until all previous calls thereon shall have been fully paid in.

9. That in case the capital stock of any company formed under this act is found to be insufficient, in the erection of the works and the operating of the same, such company may with the concurrence of two-thirds in amount of all its stockholders, increase its capital stock from time to time, to any amount required for the purpose of constructing, maintaining and operating its gas works. Such increase may be sanctioned by a vote in person or by proxy, of two-thirds in amount of all the stockholders of the company, at a meeting of such stockholders called by the directors of the company for that purpose, by a notice in writing to each stockholder, to be served on him personally, or by depositing the same, properly folded and directed to him, at the post office nearest his usual place of residence, at least twenty days prior to such meeting; such notice must state the time and place of the meeting, and its object, and the amount to which it is proposed to increase the capital stock. The proceedings of such meeting must be entered on the minutes of the proceedings of the company; and, thereupon, the capital stock of the company may be increased to the amount sanctioned by a vote of two-thirds in amount of all the stockholders of the company as aforesaid.

10. That any company organized under this act shall be a body politic and corporate, in fact and in name, by the name stated in the articles of association, and by that name have succession, and shall be capable of suing and being sued in any court of law or equity in this State, and they and their successors may have a common seal, and may make and alter the same at pleasure, and they shall, by their corporate name, be capable in law of purchasing, holding and conveying any real and personal estate whatever, which may be necessary to enable the said company to carry on the operations named in said articles of association, but shall not mortgage the same or give any lien thereon.

11. That all the stockholders incorporated under this act shall be severally, individually liable to the creditors of the company in which they are stockholders, to an amount equal to the amount of stocks held by them respectively, for all debts and contracts made by such company, until the whole amount of capital stock fixed and limited by such company shall have been paid in, and a certificate thereof shall have been made and recorded as prescribed in the following section, and the capital stock so fixed and limited shall all be paid in, one-half thereof in one year and the other half within eighteen months from the incorporation of said company, or such corporation shall be dissolved.

12. That the president and a majority of the directors, within thirty days after the payment of the last instalment of the capital stock so fixed and limited by the company, shall make a certificate stating the amount of the capital so fixed and paid in, which certificate shall be signed and sworn to by the president and a majority of the directors, and they shall, within the said thirty days, file the same in the office of the county clerk of the county wherein the business of the said company is carried on.

13. That every such company shall make a report annually, within twenty days from the first day of January, which shall be published in some newspaper published in the city, village or town where the business of said company is carried on, of the amount of capital and of the proportion actually paid in, and the amount of its existing debt, which report shall be signed by the president and a majority of the directors, verified by the oath of the president and secretary of the company, and if any company organized under this act shall fail so to do, all the directors of the company failing so to do shall be jointly and severally liable for all the debts of the company then existing, and for all that shall be contracted before such report shall be made.

14. That if the directors of any such company shall declare and pay any dividend when the company is insolvent, or any dividend the payment of which would render it insolvent, or which would reduce the amount of their capital, they shall be jointly and severally liable for all the debts of the company then existing, and for all that shall be thereafter contracted, so long as they shall respectively continue in office, *provided*, that if any of the directors shall at any time before the time fixed for the payment of such dividend object thereto, and shall, within thirty days thereafter, file a certificate of their objection in writing with the clerk of the company and with the clerk of the county, they shall be exempt from such liability.

15. That if any certificate report made or public notice given by the officers of any such company, in pursuance of the provisions of this act, shall be false in any material representation, all the officers who shall have signed the same, knowing it to be false, shall be jointly and severally liable for all the debts of the said company, contracted while they are stockholders or officers thereof.

16. That the stockholders of any company organized under the provisions of this act, shall be jointly and severally individually liable for debts that may be due and owing to all their laborers, servants and apprentices for services performed for such corporation.

17. That any corporation formed under this act shall have full power to manufacture and sell and to furnish such quantities of illuminating gas as may be required in the city, town or village where the same shall be located for lighting the streets and public and private buildings, and such corporation shall have power to lay conductors for conducting gas through the streets, lanes, alleys and squares in such city, village or town, having first obtained the written consent of the municipal authorities of such city, village or town, and under such regulations as they may prescribe.

18. That the quality of gas supplied by any company organized under this act shall be, with respect to its illuminating power, such as to produce from an English parliamentary standard Argand burner, known as the London burner for sixteen candle gas, consuming five cubic feet of gas an hour, a light equal in intensity to the light produced by not less than fourteen sperm candles of six to the pound, each burning one hundred and twenty grains an hour; and such gas shall, with respect to its

purity, be so far free from sulphuretted hydrogen that it shall not discolor paper imbued with acetate of lead, when these tests are exposed to a current of gas issuing for thirty seconds, under a pressure of five tenths of water.

19. That the meters used by any company organized under this act shall register accurately the quantity of gas passing through them and shall register the quantity of gas passing through them in cubic feet, so that the number of cubic feet of gas consumed can be easily ascertained by the consumer of such gas; and no meter shall be used that may confuse or deceive the consumer as to the number of cubic feet of gas he has consumed, or as to the price he pays for the same, per thousand cubic feet, and it shall not be lawful for any company organized under this act to charge rent on its meters.

20. That whenever any corporation formed under this act, or their servants, agents or workmen shall dig or sink any trench for laying any new mains or pipes for the conveyance of gas or other apparatus, near to which any pipe belonging to any water or gas company, owned either by the public or private individuals, for conveying water or gas, or any branch or service pipe for the supply of water or gas to any dwelling house or buildings, shall be laid, such gas company, their servants, agents or workmen, shall give twenty-four hours previous notice thereof, in writing, to the president or chief clerk or secretary or engineer of such water or gas company, owned either by the public or private individuals, such notice to be delivered to the principal office of the company, between the hours of ten in the morning and four in the afternoon, and shall under the inspection of the president or chief clerk, secretary or engineer, or such agent as may be appointed for the time being, of such water or gas company, protect and secure every such water or gas pipe from any injury, and shall also repair any damage that shall be done to such pipe, and in default of repairing such damage, the gas company shall, for each such default, forfeit and pay to the secretary for the time being, of such water or gas company, for the use of such water or gas company, any sum not exceeding twenty-five dollars, and also the costs and expenses which shall have been incurred by the said water or gas company in protecting or securing any such water or gas pipe, or in repairing or making good any injury that may have been done thereto by the means aforesaid, such costs and expenses to be ascertained by any justice, and to be recovered in the same manner as any expenses or penalty under this act may be recovered.

21. That all pipes that may be laid by any corporation formed under this act, for the conveyance of gas, shall be laid at the greatest practicable distance from the nearest part of any pipe there laid down by or by order of any water or gas company, owned by the public or private individuals, for the conveyance of water or gas, and shall be laid at a horizontal distance of four feet at least from the nearest part of any such water or gas pipe, unless in cases where it shall be unavoidably necessary to lay the gas pipe across or nearer to any water or gas pipe, in which case the said gas pipe shall be laid under the said water or gas pipe, at the greatest practicable distance therefrom, this distance in no case to be less than twelve inches, and shall form therewith a right angle, or as near thereto as the situation will admit, and in no case shall any pipe be laid, or apparatus used that will interfere in any way either with the present or future supply pipes of any water or gas company, or that may interfere with or increase the expense of replacing, removing or repairing the supply pipes or apparatus of any water or gas company, *provided*, that all gas light companies now in operation shall have the same rights and privileges of laying their mains and pipes, and making and supplying gas, that their present charters and contracts now give them.

22. That any company organized under this act, that is to supply any city, town or village that is already supplied with gas, shall, within one year after their articles of association have been endorsed by the Secretary of State, as provided for in the first section of this act, lay not less than five miles of main pipe, and furnish, upon application, to those residing on the streets, lanes or alleys in which the said main pipes may be laid, a full supply of gas, and after the expiration of said year, said company shall, within one hundred and twenty days after a written application has been received from any person or persons residing on any of the streets, lanes or alleys of the city, town or village to be supplied by said company, extend their main pipes so as to reach and supply said person or persons with gas, and the said company shall supply such person or persons with gas, in order that all may enjoy the benefits of competition, *provided*, that no company organized under this act shall be compelled to lay more than three hundred lineal feet of pipe for each and every person making a written application for gas.

23. That any company, association, person or persons, violating or neglecting to comply with any of the provisions of the

first or second sections of this act, shall be liable to a penalty of two hundred and fifty dollars for each and every offence, to be sued for and recovered in the name of the State of New Jersey, one half of which fine, when recovered, shall be paid to the informer, and the other half into the county treasury, where the action shall be tried and conviction had.

24. That the act entitled "An Act to authorize the establishment and to prescribe the duties of corporations for manufacturing and selling gas in any of the cities and towns of this State," approved March twenty-seventh, eighteen hundred and seventy-four, be and the same is hereby repealed.

25. That no exclusive privilege heretofore granted in the charter of any company to construct and operate a gas works, shall hereafter continue to be, or be construed to remain exclusive, and that no like franchise hereafter granted shall be or be construed to be exclusive, unless in such grant heretofore made or hereafter to be made, it be so expressly provided; all corporations organized under this act shall be subject to all general laws now or hereafter to be passed regulating gas companies and their operations.

26. That this act shall be deemed a public act and shall take effect immediately, and the legislature may alter, amend and repeal the same, but such repeal or alterations shall not affect any corporations heretofore organized, unless the act making such repeal or alteration shall so expressly declare.

[Revised Statutes of New Jersey, page 1341, 1877.]

GAS COMPANIES.

A supplement to an act entitled "An Act to authorize the formation of gaslight corporations and regulate the same," approved April twenty-first, one thousand eight hundred and seventy-six.

Approved March 8, 1877.

1. That the eighteenth section of the act to which this is a supplement, which reads as follows, (vide ante, p. 462), be and the same hereby is amended so as to read as follows:

That the quality of gas supplied by any company organized under this act shall be, with respect to its illuminating powers,

such as to produce from an English parliamentary standard Argand burner, known as the London burner for sixteen candle gas, consuming five cubic feet of gas an hour, a light equal in intensity to the light produced by not less than fourteen sperm candles of six to the pound, each burning one hundred and twenty grains an hour; and such gas shall, with respect to its purity, be so far free from sulphuretted hydrogen that it shall not discolor paper imbued with acetate of lead, when these tests are exposed to a current of gas, issuing for thirty seconds, under a pressure of five-tenths of water: and shall not contain more than one per centum of carbonic acid gas, nor more than two per centum of carbonic oxide gas, nor more than ten per centum of hydrogen gas, under a penalty of one hundred dollars a day for each and every day that the gas supplied is not in accordance with the requirements of this act, to be sued for and recovered, with costs of suit, on complaint, in any court of competent jurisdiction. The one-half of such penalty to be paid into the treasury and for the use of the town or city where the works of such company are located, the other half to the complainant.

[Laws of New Jersey, 1878, page 173, chap. 109.]

An Act to enable gaslight companies incorporated under the laws of this State to increase their bonded indebtedness.

1. Be it enacted, by the Senate and General Assembly of the State of New Jersey, that whenever it may be necessary for any gaslight company incorporated under the laws of this State to increase their bonded indebtedness, for the purpose of increasing their business, or for any other purpose, then and in that case the said corporation, by a majority vote of its board of directors, after having obtained the consent of a majority of the stockholders representing at least sixty (60) per cent. of the capital stock, be and they are hereby authorized to increase said bonded indebtedness to any amount not exceeding two-thirds of the amount of the capital stock of said company, the said increase as aforesaid to be governed by the law and pursued under the mode directed by the act of incoporation of such gaslight company.

2. And be it enacted, That this act shall take effect immediately.

Approved March 27, 1878.

[Laws of New Jersey, 1879, p. 206, chap. 120.]

A supplement to the act entitled "An Act to authorize the formation of gaslight corporations and regulate the same," approved, April twenty-first, one thousand eight hundred and seventy-six.

1. Be it enacted by the Senate and General Assembly of the State of New Jersey, That it shall not be lawful for any gaslight corporation to refuse to furnish or supply gas to or for any building or premises, by reason of a gas bill remaining unpaid by any previous occupant of said building or premises; *provided*, the person or persons applying for gas shall not be in arrears to the said gaslight corporation for gas previously furnished to or for said building or premises, or furnished to or for any other building or premises.

2. And be it enacted, That this Act shall take effect immediately.

Approved, March 14, 1879.

[Laws of New Jersey, 1879, p. 316, chap. 187.]

A supplement to the act entitled "An Act to authorize the formation of gaslight corporations and regulate the same."

1. Be it enacted by the Senate and General Assembly of the State of New Jersey, That it shall be lawful for any gas company now existing, whether by special charter or by organization under the act to which this is a supplement, or which may hereafter be organized thereunder, and which may be at any time actually engaged in the manufacture and supply of illuminating gas in the city, town or village for the supply of which the same was organized or chartered, to extend its main pipes to any neighboring city, town or village wherein no gas company already exists for the purpose of supplying the same with illuminating gas; *provided*, the common council, township committee or the municipal authority of such neighboring city, town or village shall grant permission for that purpose.

2. And be it enacted. That when such permission shall be granted, the said gas company shall have the same rights and privileges of laying gas mains and the like to and in such neighboring city, town or village as it has under its original organization in the city, town or village where it was originally located.

3. And be it enacted, That this Act shall take effect immediately.

Approved, March 14, 1879.

ASSEMBLY No. 27. STATE OF NEW JERSEY.

By Mr. Clark.

Introduced January 15, 1883.

A supplement to an act entitled "An act to authorize the formation of gaslight corporations and regulate the same," approved April twenty-first, one thousand eight hundred and seventy-six.

1. Be it enacted by the Senate and General Assembly of the State of New Jersey, that the first section of the act to which this is a supplement be amended so as to read as follows:

1. Be it enacted by the Senate and General Assembly of the State of New Jersey, that any number of persons not less than three may form a company for the purpose of constructing, maintaining and operating gas works, and for that purpose may make and sign articles of association in which shall be stated the name of the company, the number of years the same is to continue, the village, town or city in which it is proposed to supply and distribute illuminating gas, construct, maintain and operate the works, the amount of the capital stock of the company and the number of shares of which said capital stock shall consist, and the names and places of residence of the directors of the company, one only of whom need be a resident of this State, but he must be a resident in the particular place where the works are to be erected, who shall manage its affairs for the first year and until others are chosen in their places, each subscriber to such articles of association shall subscribe thereto his name, place of residence, and the number of shares of stock he agrees to take in said company; on compliance with the provisions of the next section such articles shall be filed in the office of the Secretary of State, who shall indorse thereon the day they are filed and record the same in a book to be provided by him for that purpose, and upon tendering such articles to the Secretary of State to be filed, the persons who have so subscribed such articles of association and all persons who shall become stockholders in such company shall be a corporation by the name specified in such articles of association.

2. And be it enacted, That section two of the act to which this is a supplement be amended so as to read as follows:

3. And be it enacted, That such articles of association shall not be filed and recorded in the office of the Secretary of State until at least one half the entire amount of the capital stock is subscribed for, and twenty per centum paid thereon in good

faith and in cash to the directors named in said articles of association, nor until there is endorsed thereon or annexed thereto, an affidavit made by at least one half in number of the directors named in said articles, that the amount of stock required by this section has been in good faith subscribed and twenty per centum paid in cash thereon as aforesaid, and that it is intended in good faith to erect the gas works and manufacture and sell gas to the city, village or town, as specified in the articles of association, which affidavit shall be recorded with the articles of association as aforesaid.

3. And be it enacted, That the fourth section of the act to which this is a supplement be amended so as to read as follows:

4. And be it enacted, That when such articles of association and affidavit are filed and recorded in the office of the Secretary of State, the directors named in such articles of association may, in case the whole of the capital stock is not before subscribed, continue to receive subscriptions until the whole capital stock is subscribed; the capital stock of any corporation organized under this act shall not be less than one thousand dollars for every thousand of the population of the village, town or city in which it is proposed to erect the works or lay the pipes in order to supply said village, town or city with illuminating gas, the number of population to be taken from the latest census of the population, whether the same was made by the general or State government; at the time of subscribing, every subscriber shall pay to the directors twenty per centum of the amount subscribed by him in money, and no subscriptions shall be received or taken without such payment; the remainder of the stock subscribed for, or any part thereof, or any stock issued as increased capital stock, the directors may issue to the subscriber or his assigns, or any purchaser thereof for property necessary for the company's business, to the amount of the value of such property; stock so issued shall be declared and taken to be full paid stock and not liable to further call; but that stock shall have legibly marked upon its face the words "issued for property purchased," and in all the company's statements and reports to be published it shall not be stated as being issued for cash paid into the company, but shall be reported in this respect according to the fact.

4. And be it enacted, That section five of the act to which this is a supplement be amended so as to read as follows;

5. And be it enacted, That there shall be a board of not less than three directors of every corporation formed under this act

to manage its affairs; such directors shall be chosen annually by a majority of the votes of the stock-holders voting at such election in such manner as may be prescribed in the by-laws of the corporation, and they may and shall continue to be directors until others are elected in their places; in the election of directors each stockholder shall be entitled to one vote for each share of stock held by him; vacancies in the Board of Directors shall be filled in such manner as shall be prescribed by the by-laws of the corporation; the inspectors of the first election of directors shall be appointed by the directors named in the articles of association; no person shall be a director unless he shall be a stockholder owning stock absolutely in his own right and qualified to vote for directors at the election at which he shall be chosen; at every election of directors the books and papers of such company shall be exhibited to the meeting, provided a majority of the stockholders shall require it; non-resident stockholders may vote.

5. And be it enacted, That section eleven of the act to which this is a supplement be amended so as to read as follows:

11. And be it enacted, That each stockholder shall be liable for the company's debts to the amount unpaid in the stock held by him until the amount of his stock shall have been paid in in full.

6. And be it enacted, That this act shall take effect immediately.

SENATE AMENDMENT; ASSEMBLY No. 27, STATE OF NEW JERSEY.

A further supplement to an act, entitled "An act to authorize the formation of gaslight coporations, and regulate the same," approved April twenty-first, one thousand eight hundred and seventy-six.

1. Be it enacted by the Senate and General Assembly of the State of New Jersey, That the twenty-second section of the act to which this is a supplement be and the same is hereby amended so as to read as follows:

22. And be it enacted, That any company organized under this act, that is to supply any city, town or village that is already supplied with gas, shall within two years after their articles of association have been endorsed by the Secretary of State, as provided for in the first section of the act to which this is a supplement, lay main gas pipes between the curb stones, in all the

streets, lanes or alleys in said city, town or village, as far as the main gas pipes of the existing gas company or companies are laid, none of said main gas pipes to have an internal diameter of less than six inches, when laid in any street or avenue having a width between the curb stones of twenty-five feet or over, and no main gas pipes to be laid having an internal diameter of less than four inches; and furnish, upon application, to those residing on the streets, lanes or alleys in which said main gas pipes may be laid, a full supply of gas, in order that all the consumers of gas may enjoy the benefits of competition, and if said main gas pipes are not so laid as herein provided, such corporation shall cease to exist, and may be dissolved and enjoined from the exercise of any of its franchises.

2. And be it enacted, That the eighteenth section of the act to which this is a supplement be and the same is hereby amended so as to read as follows:

18. And be it enacted, That the quality of gas supplied by any company organized under this act, shall be, with respect to its illuminating powers, such as to produce from an English parliamentary standard argand burner, known as the London burner for sixteen-candle gas, consuming five cubic feet of gas an hour, a light equal in intensity to the light produced by not less than fourteen sperm candles of six to the pound, each burning 120 grains an hour; and such gas shall, with respect to its purity, be so far free from sulphuretted hydrogen that it shall not discolor paper imbued with acetate of lead, when these tests are exposed to a current of gas, issuing for thirty seconds under a pressure of five-tenths of water, and shall not contain more than eight per centum of carbonic oxide gas, under a penalty of one hundred dollars a day for each and every day that the gas supplied is not in accordance with the requirements of this act, to be sued for and recovered, with costs of suit, on complaint, in any court of competent jurisdiction, the one-half of such penalty to be paid into the treasury and for the use of the town or city where the works of such company are located, the other half to the complainant.

3. And be it enacted, That the act, entitled "A supplement to an act, entitled 'An act to authorize the formation of gaslight corporations, and regulate the same, approved April twenty-first, one thousand eight hundred and seventy-six,' approved March eighth, one thousand eight hundred and seventy-seven" be and the same is hereby repealed.

4. And be it enacted, That the fourth section of the act to which this is a supplement be and the same is hereby amended so as to read as follows:

4. And be it enacted, That when such articles of association and affidavit are filed and recorded in the office of the Secretary of State, the directors named in such articles of association may, in case the whole of the capital stock is not before subscribed, continue to receive subscriptions until the whole capital stock is subscribed; the capital stock of any corporation organized under this act shall not be less than five thousand dollars for every thousand of the population of the village, town or city in which it is proposed to erect the works or lay the pipes, in order to supply said village, town or city with illuminating gas, the number of population to be taken from the latest census of the population, whether the same was made by the general or State government. At the time of subscribing every subscriber shall pay to the directors twenty per centum of the amount subscribed by him in money, and no subscriptions shall be received or taken without such payment; the remainder of the stock subscribed for, or any part thereof, or any stock issued as increased capital stock, the directors may issue to the subscriber or his assigns, or any purchaser thereof, for property necessary for the company's business, to the amount of the value of such property; stock so issued shall be declared and taken to be full paid stock, and not liable to further call, but that stock shall have legibly marked upon its face the words, "issued for property purchased," and in all the company's statements and reports to be published it shall not be stated as being issued for cash paid into the company, but shall be reported in this respect according to the fact.

5. And be it enacted, That this act shall take effect immediately.

SENATE, March 22, 1883.

This bill having been three times read in the Senate,

Resolved, That the same do pass,

By order of the Senate,

JOHN J. GARDNER,

President of the Senate.

HOUSE OF ASSEMBLY, March 22, 1883.

This bill having been three times read and compared in the House of Assembly,

Resolved, That the same do pass.

By order of the House of Assembly,

THOS. O'CONNOR,

Speaker of the House of Assembly.

The Governor did not approve Assembly Bill No. 27, assigning the following reason:

This bill comes to me in such a shape as to create a serious doubt as to whether the original bill or the substitute passed the Legislature, both being signed by the presiding officers of the two Houses. Concurrent testimony shows that the Senate substitute was adopted in the Assembly, but this substitute is not properly engrossed, and I therefore have declined to sign it.

ASSEMBLY, No. 28. STATE OF NEW JERSEY.

BY MR. CLARKE.

Introduced January 15, 1883.

An act to repeal an act approved March eighth, one thousand eight hundred and seventy-seven, and entitled "A supplement to an act entitled 'An act to authorize the formation of gaslight corporations and regulate the same,' approved April twenty-first, one thousand eight hundred and seventy-six."

1. Be it enacted by the Senate and General Assembly of the State of New Jersey, That an act approved March eighth, one thousand eight hundred and seventy-seven, and entitled "A supplement to an act entitled 'An act to authorize the formation of gaslight corporations and regulate the same,' approved April twenty-first, one thousand eight hundred and seventy-six" be and the same is hereby repealed.

2. And be it enacted, That this act shall take effect immediately.

APPENDIX D. PAPER 2.

[Public Statutes of Massachusetts, 1882, Chap. 61.]

Of the Inspection of Gas and Gas-Meters.

Section 1. There shall be an Inspector and an Assistant Inspector of gas-meters and of illuminating gas appointed by the Governor, with the advice and consent of the Council, and who shall be sworn to the faithful discharge of their duties. The inspector shall hold office for three years from the time of his appointment and until the appointment of his successor, but may be removed by the Governor and Council at their pleasure. The Assistant Inspector shall hold office for three years from the time of his appointment, unless sooner removed as aforesaid.

Sec. 2. The salary of the inspector shall be two thousand dollars a year, which shall include such portion of his office rent and expenses as shall not be paid out of the fees as provided in section six, and the salary of the assistant inspector shall be twelve hundred dollars a year, and the inspector and assistant inspector shall be paid in addition to their salaries, all actual travelling expenses necessarily incurred by them in the performance of their official duties. Said salaries and expenses shall be paid out of the Treasury of the Commonwealth, but no larger amount shall be so paid out than is actually paid into the treasury in the manner hereinafter provided.

Sec. 3. The Inspector shall give a bond to the Treasurer of the Commonwealth in the penal sum of five thousand dollars for the faithful discharge of the duties of his office, and the assistant inspector shall give like bond in the penal sum of two thousand dollars.

Sec. 4. The Inspector and Assistant Inspector shall not in any way, directly or indirectly, be interested pecuniarily in the manufacture or sale of illuminating gas, of gas meters, or of any article or commodity used by gaslight companies, or used for any purpose connected with the consumption of gas or with a gas company, and shall not give certificates or written opinions to a maker or vendor of any such article or commodity.

Sec. 5. The Inspector shall have an office in Boston, and shall, when required as hereinafter provided, inspect, examine, prove and ascertain the accuracy of any and all gas meters to be used for measuring the quantity of illuminating gas to be furnished to or for the use of any person, and shall seal, stamp, or mark every such meter, when found to be correct, with some suitable device which shall be recorded in the office of the Secretary of the Commonwealth, and with the inspector's name, the date of his inspection, and the number of burners which the meter is calculated to supply. He shall also annually, in the month of January, report to the General Court the number of meters inspected and sealed during the preceding year, with such other information as he may deem expedient. The assistant inspector shall, under the direction of the inspector, aid him in performing the duties of his office.

Sec. 6. When the Inspector finds himself unable to attend to his duties in any city or town, he shall appoint temporarily, and for such time as he deems expedient, one or more deputy inspectors of meters for the county in which such city or town is

situated. Such deputies shall be duly sworn, and shall act under his direction ; they shall not be connected with or employed by any gas company, and shall be subject to the same disabilities as are set forth in section four, and from their decisions appeals to the inspector may be taken by the gas company or by the consumer. The inspector shall be entitled to collect for the services of such deputies in examining, comparing and testing meters, with or without stamping them, a fee of twenty-five cents for each meter delivering not more than a cubic foot of gas in four revolutions, vibrations, or complete repetitions of its action, and for each meter so delivering more than a cubic foot a fee of thirty cents, with twenty cents added for every additional cubic foot so delivered. Out of the fees so collected by the inspector he shall pay to said deputies such reasonable salaries as may be agreed on, and any balance of said fees that may remain he may apply to the payment of his own office rent and office expenses.

Sec. 7. The amount of the salaries of the inspector and assistant inspector and of their travelling expenses, together with any expenses incurred under section nine, shall be annually assessed and paid into the Treasury of the Commonwealth by the several gaslight companies in the commonwealth, in amounts proportionate to their appraised valuation as declared in the returns required to be made by them to the assessors annually in May ; and in case any such company refuses or neglects, for thirty days after written notice given by the Treasurer of the Commonwealth, to pay into the treasury the amount required of such company on account of such salaries and expenses, then the said treasurer shall, in the name of and for the use of the commonwealth, sue such company for such amount, with interest thereon at the rate of ten per cent. per annum from the time when said notice was given, and for the costs of the action.

Sec. 8. The unit of measure for the sale of illuminating gas by meter shall be the cubic foot, containing sixty-two and three hundred and twenty-one one-thousandths pounds avoirdupois weight of distilled or rain water, weighed in air of the temperature of sixty-two degrees, Fahrenheit scale, the barometer being at thirty inches.

Sec. 9. The inspector shall provide at his office such apparatus and chemicals as, in his jugdment, are necessary for the faithful performance of the duties of the office.

Sec. 10. Every gaslight company, with a capital paid in of one hundred thousand dollars or more, and every maker and

vendor of meters shall set up at some convenient place upon their premises a gas-holder, to be tested, and, if correct, stamped and sealed, containing five or more cubic feet, by means of which meters shall be tested at the average pressure at which gas is supplied in the city or town where they are to be used, attention being paid to the temperature of the room where the trial is made. Every gaslight company shall provide a test meter, of a construction approved by the inspector and stamped by him, to be used in cities and towns where no test gas-holders are provided, or whenever proving by a gas-holder is impracticable or inconvenient. In the examination of a meter the inspector shall see that it is of an approved principle, and shall give particular attention to the measure of the dial plate; he shall prove the meter when set level, and, for each burner which the manufacturer has stamped it to register, it shall be capable of passing gas accurately at the rate of six cubic feet per hour; and no dry meter shall be stamped correct which varies more than two per cent. from the standard measure, and no wet meter shall be stamped correct which is capable of registering more than two per cent. against the consumer or more than five per cent. against the company. The inspector shall keep at his office a correct record of all meters inspected by him, with their proof at the time of inspection, which record shall be open at all times for examination by the officers of any gaslight company in the commonwealth.

Sec. 11. No meter shall be used for measuring gas supplied to a consumer, unless it is duly sealed and stamped; and for every meter in use and not so sealed and stamped, the gas company supplying it shall pay a fine of five dollars to the city or town where the meter is situated.

Sec 12. Meters in use shall be tested by the inspector or by his assistant or deputy on the request of the consumer or of the gaslight company, in the presence of the consumer if desired, and with sealed apparatus. If the meter is found to be correct, the party requesting the inspection shall pay the fees for such inspection and the expense of removing the meter for the purpose of being tested, and the reinspection shall be stamped on the meter. If the meter is proved to be incorrect, the gaslight company shall pay such expenses, and shall furnish a new meter without charge to the consumer.

Sec. 13. Every gaslight company annually manufacturing more than fifteen million cubic feet of gas shall provide a suitable

room, at least a quarter of a mile from the gas works, containing a disc photometer of a construction approved by the inspector; and such room shall be open to the inspector and his assistant on every working day from eight o'clock in the morning till six o'clock in the afternoon.

Sec. 14. The gas of every company supplying more than fifty consumers shall be inspected at least twice a year, and one additional inspection shall be made for every four million cubic feet of gas supplied by each company; but the gas of no company shall be inspected oftener than once a week. All such inspections shall be made by the inspector or his assistant, and one-fourth at least of all such inspections shall be made by the inspector. The gas shall be tested for illuminating power by means of a disc photometer, and, during such test, shall be burned from the burner best adapted to it, which is at the same time suitable for domestic use, and at as near the rate of five feet per hour as is practicable. When the gas of any company is found on three consecutive inspections to give less light than fifteen standard English candles, or to contain more than twenty grains of sulphur or ten grains of ammonia per hundred cubic feet of gas, or more than ten per cent. of carbonic oxide, or any sulphuretted hydrogen, a fine of one hundred dollars shall be paid by such company to the city or town supplied by it. When during the test the consumption of gas varies from five feet per hour, or the candle from one hundred and twenty grains per hour, a proportionate correction shall be made for the candle power.

Sec. 15. Any officer or servant of a gaslight company, duly authorized in writing by the president, treasurer, agent or secretary of said company may, at any reasonable time, enter any premises lighted with gas supplied by such company, for the purpose of examining or removing the meters, pipes, fittings and works for supplying or regulating the supply of gas, and of ascertaining the quantity of gas consumed or supplied; and if any person directly or indirectly prevents or hinders such officer or servant from so entering such premises, or from making such examination or removal, such officer or servant may make complaint under oath to a Justice of the Peace, stating the facts in the case so far as he has knowledge thereof, and the said justice may thereupon issue a warrant directed to the sheriff or to either of his deputies, or to a constable of the city or town where such company is located, commanding him to take sufficient aid and repair to said premises accompanied by such officer or servant,

who shall examine such meters, pipes, fittings and works for supplying or regulating the supply of gas, and ascertain the quantity of gas consumed or supplied therein, and shall, if required, remove any meters, pipes, fittings and works belonging to said company.

Sec. 16. If any person supplied with gas neglects or refuses to pay the amount due for the same, or for the rent of the meter or other articles hired by him of the gaslight company, such company may stop the gas from entering the premises of such person. In such cases the officers, servants or workmen of the company may, after twenty-four hours' notice, enter the premises of such person between the hours of eight in the forenoon and four in the afternoon, and separate and take away such meter or other property of the company, and may disconnect any meter, pipes, fittings or other works, whether the property of the company or not, from the mains or pipes of the company.

Sec. 17. Every person who wilfully or fraudulently injures or suffers to be injured any meter, pipes or fittings belonging to a gaslight company, or prevents a meter from duly registering the quantity of gas supplied through the same, or in any way hinders or interferes with its proper action or just registration, or fraudulently burns or wastes the gas of such company, shall for every such offence forfeit to the company not more than one hundred dollars, to be recovered in an action of tort, and, in addition thereto, shall pay to the company the amount of damage by it sustained by reason of such injury, prevention, waste, consumption or hinderance.

Sec. 18. Every person who attaches a pipe to a main or pipe belonging to a gaslight company, or otherwise burns or uses or causes to be used without the written consent of such company any gas supplied by it, unless the same passes through a meter set by the company, shall forfeit to said company the same fine and in the same manner as declared in the preceding section.

Sec. 19. The provisions of this chapter shall apply to all companies which manufacture gas for sale.

APPENDIX D. PAPER 3.

Office of the Board of Health,
and Vital Statistics of Hudson County, N. J.,
Jersey City, May 23, 1883.

I enclose with this a letter on the subject of gas from W. W. Thomas, Superintendent People's Gas Company. He regrets

that his time will not permit of his giving the complete exposition of the subject that he hoped to give.

There has never been any water gas manufactured in this State. It was tried in Hoboken and given up.

Yours truly,

C. J. ROONEY, Jr.,

Clerk.

P. S. If you cannot get "American Progress" with gas article, Mr. Thomas tells me he will be pleased to loan it to you.

Yours, &c.,

C. J. R., Jr.

People's Gaslight Company,
Newark Avenue, opposite Court House,
Jersey City Heights, May 22, 1883.

[Annual manufacture of gas, 36,000,000 feet—all coal gas.]

C. J. Rooney, Esq., *Clerk of Board of Health, Jersey City:*

Dear Sir:

Yours of the 24th ult., containing circular in regard to gas, also a card of a later date, were duly received; owing to a press of business I have been unable to answer sooner. There was a general law in this State prohibiting the manufacture of water gas or any gas containing a certain percentage of carbonic oxide. This law was in force until 1878 or 1879; about this time it was repealed through the influence of a State senator who was interested in the manufacture of water gas in one of our large cities. At the last session of our Legislature there was a bill passed by both houses prohibiting the manufacture in cities of the first class (Jersey City and Newark), of any gas containing more than ten per cent of carbonic oxide, which was vetoed by the Governor on the ground that it was unconstitutional; if this bill had become a law it would have been impossible to have manufactured gas from the decomposition of water, from the fact that there is from thirty to forty per cent. of carbonic oxide produced in the decomposition which would have been from twenty to thirty per cent. in excess had this bill become a law. It would be superfluous for me to say anything in regard to the poisonous effects of carbonic oxide, as the Commissioner is no doubt aware of all such facts.

As the Commissioner asks for analyses of gases I have two before me made by Prof. Henry Wurtz, Ph. D., which are as follows:

Coal Gas.	
Hydrogen	42.47
Carbonic oxide	2.08
Marsh gas	46.16
Illuminants	6.67
Air	2.62
	100.00

Water Gas.	
Hydrogen	38.20
Carbonic oxide	27.14
Marsh gas	15.82
Illuminants	15.29
Nitrogen and oxygen	3.45
Carbonic acid	.10
	100.00

For valuable information in regard to this subject I would recommend the perusal of an article published in "American Progress," dated March 24, 1883, entitled Poisonous Illuminating Gas, in which will be found a list of the deaths occurring since the introduction of water gas in the cities of New York and Brooklyn, with other valuable information. These works have been in operation since 1869; there has been but one death from the effects of gas in that time—(the Buck case.)

Very respectfully yours,

WILLIAM W. THOMAS,

Superintendent.

APPENDIX E. PAPER 1.

HEALTH DEPARTMENT, No. 301 Mott Street,
NEW YORK, May 4, 1883.

In reply to your favor, I would say that my opinion, with regard to water gas, has not changed since I made the official report which was printed in the "City Record."

I will take the earliest moment to hunt up a copy of this report and send it to you; and I would say that I have been using this gas in my house for years and I have never had any reason to believe that any greater danger attends its use than attends the use of ordinary coal gas. Both are poisonous and both will suffocate.

I have read pamphlets and arguments that have been published against the water gas, and I have seen the long list of fatalities alleged to result from its use, but I do not believe that a lesser number of fatalities would have resulted had ordinary coal gas been employed.

Very truly yours,

C. F. CHANDLER.

[Opinion of Prof. C. F. Chandler. From the "City Record."]

COMMUNICATIONS FROM THE DEPARTMENTS AND CORPORATION OFFICERS.

The President laid before the Board the following communication from the Board of Health:

HEALTH DEPARTMENT, NEW YORK, April 15, 1881.

To the Honorable the Board of Aldermen:

At a meeting of the Board of Health, held on the 13th inst., the following report of the President was unanimously adopted, and a copy was ordered to be forwarded to your Honorable Body:

REPORT.

I have the honor to report that the petition of citizens referred to the Board of Health by the Honorable the Board of Aldermen, with regard to the illuminating gas which is manufactured from steam, anthracite coal and naphtha, the so-called "water gas" has been duly considered.

This gas has been extensively used in the city of New York for some years, in public and private buildings. While it differs somewhat in composition from the gas manufactured from bituminous coal, it involves in its careless use the same sources of danger; if allowed to escape into the air without being burned it produces an explosive mixture with the air, and it is also liable to suffocate persons who may remain for any length of time in the atmosphere thus contaminated. There are no facts which give any substantial foundation for the apprehensions of the petitioners that this gas is in any way more dangerous than the gas previously in use. I would further state that the allegation that this "water gas" has been prohibited in Paris is directly denied by Professor Adolph Wurtz of that city in a letter which I have before me; that the greater density of the gas causes it to escape more slowly from leaks than does ordinary coal gas, and that its odor is so decided that leaks are detected just as readily as in the case of other gas. In conclusion I would say that I see no reason why any official action should be taken on this subject.

C. F. CHANDLER,
President.

(A true copy.)

——————————, *Secretary.*

Which was referred to the Committee on Police and Health Departments.

APPENDIX E. PAPER 2.

STEVENS INSTITUTE OF TECHNOLOGY,
HOBOKEN, N. J., May 2, 1883.

I send you by this a copy of the Gaslight Journal containing my first article on the carbonic oxide question, with the important passages marked on page 113.

I have seen no reason to change my opinion, but some of my friends quote one half and others the other half and each take comfort for themselves.

I regard carbonic oxide as a highly poisonous gas, much more dangerous than any other constituent of illuminating gas, but I also hold that the greater danger attending its use is very limited in its range of application because there will be but few cases where it gets out of the pipes; and secondly, I believe that risk will have little to do with the introduction and use of anything which is otherwise desirable. Witness steam, matches, electricity, nitro-glycerine, &c.

Very truly yours,
HENRY MORTON.

THE AMERICAN GASLIGHT JOURNAL, N. Y., SATURDAY, MARCH 2 AND 16, 1878.

CARBONIC OXIDE.

IS IT A HARMLESS ANÆSTHETIC OR A VIRULENT POISON?

By Henry Morton, Ph.D., President of the Stevens Inst. of Technology.

In reply to questions put to me on the subject some time since, I stated that carbonic oxide, according to the opinion of the standard writers, was undoubtedly a virulent poison, and therefore, that this gas was a very objectionable constituent in any mixture which was to be distributed for illuminating or other purposes.

Since the publication of this statement of mine I have noticed that there have been published, in various journals, or printed and circulated, various statements which, more or less indirectly, seem to call in question the soundness of my views on this subject.

As, after all, this is simply a question of fact, on which any one, with the data before him, is competent to form a judgment,

I have thought it worth while to compile all the statements by standard authors which were in my reach, and so let them speak for themselves. Whether or not such a gas, as will be there found described, should be considered a "virulent poison," and would be "objectionable," may then be left to the reader for decision, with his common sense for a sufficient guide.

Following a general chronological order in the succession of quotations, I find as follows:

Murray's Chemistry, Edinburgh, 1809, vol. ii., p. 546. Under "carbonic oxide," he says: "It is fatal to life when inspired."

Cutbush's Chemistry, Philadelphia, 1813, vol. i., p. 126. Under "carbonic oxide." "Experiment 4. If a mouse or other small animal be immersed in a jar of this gas it will destroy it in a short time. Remark. This gas is, therefore, deleterious to animal life. When respired for a few minutes it produced giddiness and fainting."

Gorham's Chemistry, 1819, vol. i., p. 380. Under the heading "carbonic oxide." "It is incapable of supporting combustion, and is fatal to animal life. Sir H. Davy once took three inspirations of it mixed with about one-fourth of common air; the effect was a temporary loss of sensation which was succeeded by giddiness, sickness and acute pains in different parts of the body, and extreme debility. Some days elapsed before he entirely recovered."

Brande's Chemistry, London, 1821, vol. i., p. 120. Under "carbonic oxide," he says: "It is fatal to animals." Of carbonic acid he says only (p. 429) "It is irrespirable."

Ure's Dictionary of Chemistry, 1821. Article, "'Carbonic oxide' when inspired is fatal to animal life." The account of Sir H. Davey follows, and then: "Since then Mr. Wilter, of Dublin, was struck down in an apoplectic condition by breathing this gas, but he was speedily restored by the inhalation of oxygen."

Parkes' Chemical Catechism, N. Y., 1818, p. 406. Under "carbonic oxide." "It is a gas that will not itself support combustion, neither is it fit for animal respiration. According to some French chemists, birds drop down dead immediately on being put in this gas. These chemists attempted to breathe it themselves, but it produced giddiness and faintness.—*Annales de Chimie*, t. xxxix, p. 56."

Henry's Chemistry, London, 1823, vol. i., p. 347. Under "carbonic oxide." "It is extremely noxious to animals, and fatal to them if confined in it."

Webster's Chemistry, Boston, 1828, p. 203. Under "carbonic oxide." "It is extremely noxious to animals, and fatal to them if confined in it. When respired for a few minutes it produces giddiness and fainting."

Thompson's Chemistry, London, 1831, vol. i., p. 168. Under "carbonic oxide." "No animal can breathe it; when the attempt is made one or two inhalations occasion asphyxia. All gases containing carbon have been found positively injurious when drawn into the lungs."

Thenard's Chemistry, Paris, 1834, t. i., p. 274. Under "Carbonic oxide." "It kills immediately the animals who breathe it."

Berzelius' Chemistry, Paris, 1838, t. i., p. 222. Under "carbonic oxide." "Animals die immediately in carbonic oxide gas, and persons who have tried to breathe it have fallen down unconscious."

Daniel's Chemistry, London, 1843, p. 356. Under "carbonic oxide." "It is speedily fatal to animals."

Turner's Chemistry, 1847, p. 232. Under "carbonic oxide gas." "It cannot support respiration. It acts injuriously on the system, for, if diluted with air and taken into the lungs, it very soon occasions headache and other unpleasant feelings, and when breathed pure it almost immediately causes profound coma."

Graham's Chemistry, London, 1850, vol. i., p. 370. Under "carbonic oxide." "It is very fatal to animals, and when inspired in a pure state almost immediately produces profound coma." Of carbonic acid he says simply (p. 364), it "does not support animal life."

Encyclopedia of Chemistry, by Booth and Morfit, Philadelphia, 1850, p. 418. Under "carbonic oxide." "No animal can breathe it, and it is more poisonous than carbonic acid."

Gmelin's Chemistry, London, 1849, vol. ii., p. 89. Under "carbonic oxide." "Small animals immersed in it die instantly. When inspired it produces giddiness and fainting fits. (Clement and Desormes), even mixed with a fourth its bulk of air (H. Davy); it is much more poisonous than carbonic acid."

Regnault's Chemistry, Philadelphia, 1852, vol. i., p. 321. "Oxide of carbon is not merely passive in not supporting respiration, but is active as a poison; for an animal perishes if left for some time in an atmosphere containing a few per cent. of this gas.

To its presence must be attributed the uneasiness and headache experienced by remaining in a badly ventilated apartment, near a furnace containing burning charcoal, the products of which do not immediately pass up the chimney. If a large proportion of carbonic oxide gas be present in a closely shut room death ensues from asphyxia."

Chenot. Article in the Comptes Rendus of the French Academy, 1854, p. 735. "On pure carbonic oxide considered as a poison."

In this article its author describes the action of carbonic oxide in such terms as the following:

"The pure carbonic oxide is not simply a reducing agent of the greatest energy, but a frightful poison (*un poison foudroyant*) in very small dose. Finally, it appears that poisoning by carbonic oxide is the most terrible in itself and brings after it profound disorganization." This author speaks from his own experience, having suffered several times very seriously from accidental inhalations of small quantities of this gas. In a continuation of this same subject, at a subsequent date, (see p. 830 of the same volume) M. Chenot relates a number of facts which had been brought to his notice illustrating the dangerous properties of carbonic oxide even when mingled with air.

Payen's Industrial Chemistry, Paris, 1859, t. i., p. 93, foot note (*) "The production of 'carbonic oxide,' in consequence of an insufficient quantity of air (or oxygen) during combustion, occasions great danger to the health of the workmen if this poisonous gas is mingled with the air which they breathe."

Stockhardt's Chemistry, Philadelphia, 1861, p. 100. "CO, 'carbonic oxide' is extremely poisonous when inhaled, and constitutes what the miners call coal gas. * * * Notwithstanding repeated warnings accidents not seldom occur from the fumes of burning charcoal."

Lorme's Chemistry, Paris, 1861, t. i., p. 318; *Note.* "The gas 'carbonic oxide' is produced in large quantity when carbon burns in an insufficient quantity of air. It is this which sometimes happens in our rooms. It is especially to the presence of this gas that we should attribute asphyxia from coal, and not to carbonic acid. There is great danger in breathing air which contains some hundredths of carbonic oxide; this gas acts as a

* The original article by Desormes and Clement will be found in the Annales, vol. 39, p. 26. The passage here quoted is on page 56.—H. M.

pure poison, thus to escape the deleterious influences which it exercises on the constitution it is necessary to ventilate thoroughly the rooms in which carbon is burned."

Chemical News. Article by H. Letheby, Prof. of Chem. and Toxicology in the Medical College of the London Hospital, April 19, 1862, p. 212. "'Carbonic Oxide' was discovered by Priestley long before the close of the last century; and in 1802, Clement and Desormes, at the instance of Guyton Morveau, undertook a careful examination of its properties. They not only proved its chemical nature, but they also ascertained that it was a poisonous gas. Birds put into it dropped dead before they could be taken out; and when the experimenters themselves attempted to breathe it they were attacked with giddiness and faintness. * * * * Later still, in 1814, the two assistants of Mr. Higgins, of Dublin, made experiments with it upon themselves, and in one case, that of Mr. Wilter, with almost a fatal result. Having exhausted the lungs of air, he inhaled the pure gas three or four times, and was suddenly deprived of sense and volition; he fell upon the floor and continued in a state of perfect insensibility, resembling apoplexy, and with a pulse nearly extinct. Various restorative means were employed, but without success, until they resorted to the use of oxygen, which was forced into his lungs, and then his life was restored; but he was affected with violent convulsive agitation of the body for the rest of the day. He suffered also from violent headache, stupor, and a quick, irregular pulse. Even after mental recovery he suffered from giddiness, blindness, nausea, alternate heats and chills, and irresistible sleep. The other gentleman, after inhaling the gas two or three times, was seized with giddiness, tremor and incipient insensibility. These effects were followed by languor, weakness and headache of some hours' duration.

"Since those experiments were made, others of a more extended character were instituted by Tourdes and by Leblanc. Tourdes found that rabbits were killed in seven minutes when they were put into a mixture of one part of the gas with seven of atmospheric air. A fifteenth part of the gas in common air killed them in twenty-three minutes, and a thirtieth part in thirty-seven minutes. Leblanc's experiments were made in conjunction with Dumas, and he ascertained that one per cent. of the gas in atmospheric air would kill a small dog in a minute and a half, and that birds were killed immediately in a mixture containing five per cent. of it.

"Very recently I have myself ascertained that air containing only 0.5 per cent. of the gas will kill small birds in about three minutes, and that a mixture containing one per cent. of the gas will kill in about half this time. An atmosphere having two per cent. of the gas will render a guinea pig insensible in two minutes; and in all these cases the effects are the same. The animals show no sign of pain; they fall insensible, and either die at once with a slight flutter—hardly amounting to convulsion—or they gradually sleep away as if in profound coma. * * *

"Accident has also demonstrated how injurious the gas is even to the human subject. For many years past attempts have been made to promote the use of water gas as an agent of illumination. The gas sometimes contains as much as thirty-four per cent. of carbonic oxide. It is obtained by passing steam over red-hot charcoal, and as the steam is decomposed by the ignited carbon, the hydrogen is set free, and carbonic oxide, with carbonic acid, is produced. Patents for this process of manufacturing gas date as far back as the year 1810, and they have at various times been put into operation in this country and on the continent. Selligue, in 1840, obtained permission to use the gas in the towns of Dijon, Strasburg, Antwerp, and two of the faubourgs of Paris and Lyons. At Strasburg an accident occurred which put a stop to its use. The gas escaped from the pipes into a baker's shop, and was fatal to several persons; and not long after an æronaut, named Delcourt, incautiously used the gas for inflating his balloon. He was made insensible in the car, and those who approached the balloon to give him assistance fainted and fell likewise. The use of the gas, therefore, has been interdicted on the continent."

Reissig. Munich. Hand book of wood and peat illuminating gas manufacture, Munich, 1863, p. 59. Speaking of wood gas especially, he says that its inhalation may produce death. "This latter gas, in particular, is dangerous on account of its large contents of carbonic oxide. Hydrogen, and light carburetted hydrogen, can be much more readily respired without injurious consequences; but not so carbonic oxide. The poisonous effects of this gas are known. Every year the lives of many are sacrificed to it, persons who are suffocated by the so-called charcoal fumes, *i. e.*, carbonic oxide. Great caution, therefore, should be used, and the main cock should be turned every evening by some reliable person, so that only small quantities of the gas can escape.

Bloxam's Chemistry, London, 1868, p. 78. "Carbonic oxide is a gas of so poisonous a character that, according to Leblanc, one volume of it diffused through 100 volumes of air totally unfits it to sustain life; and it appears that the lamentable accidents which too frequently occur from burning charcoal or coke in braziers and chafing-dishes in close rooms, result from the poisonous effects of the small quantity of carbonic oxide which is produced and escapes combustion, since the amount of carbonic acid thus diffused through the air is not sufficient in many cases to account for the fatal results."

Fowne's Chemistry, Philadelphia, 1869, p. 168. Under "carbonic oxide." "It is colorless, has very little odor, and is extremely poisonous—much more so than carbon dioxide."

The peculiar red color of the blood observed in the bodies of those poisoned by carbonic oxide long after death was noticed at a very early period (at least prior to 1850), and in 1865 an elaborate investigation was published by Hoppe-Seyler, in the Zeitschrift fur Analyt. Chemie, vol. iii, p. 439. A good abstract of this will be found in the Philosophical Magazine, series iv, vol. xxx, p. 456.

It is entitled "On the detection of poisoning by carbonic oxide," and shows how the changes in the blood, produced by this poison, can be recognized by the spectroscope even after many days.

Miller's Chemistry, London, 1867, vol. ii, p. 72. Under "carbonic oxide." "When respired, even though largely diluted with air, it acts as a direct poison, producing a peculiar sensation of oppression and lightness of the head."

Duflos' Handbuch der angewandten Chemie. Leipzig, 1873, p. 36. "A contents of one-fourth per cent. of carbonic oxide in air gives it the above mentioned injurious action (dizziness, vomiting, fainting and finally death), and even with a much smaller amount in a prolonged exposure to such an atmosphere, health may be very seriously endangered."

Hasselt. Handbuch der Giftlehre fur Chemiker, etc., 1862. In vol. ii, on p. 352, says: "Carbonic oxide" has been found to be a most active narcotic poison for man. The poisonous effects of coal gas are probably due to this.

Hermann. Lehrbuch der experimentallen Toxikologie, 1874, Berlin. "Warm blooded animals soon die in an atmosphere containing carbonic oxide; even very small quantities down to one per cent. are sufficient."

Bernard. Lecons sur les effets des substances toxiques. Paris, 1856. This author says: Carbonic oxide is one of the most poisonous gases known.

Eliot & Storer's Chemistry, New York, 1871, p. 338. Under "carbonic oxide." "It extinguishes combustion just as hydrogen does, and destroys animal life. Unlike hydrogen and nitrogen, however, it is a true poison. It destroys life, not negatively by mere suffocation or exclusion of oxygen, but by direct noxious action. Even when largely diluted with air it is still poisonous, producing giddiness, insensibility, and finally death. It is the presence of this gas which occasions the peculiar sense of oppression and headache which is experienced in rooms in which the products of combustion have escaped from fires of charcoal or anthracite. Carbonic oxide is very much more poisonous than carbonic acid. Much of the ill repute which attaches to carbonic acid really belongs to carbonic oxide; for since both these gases are produced by burning charcoal, many persons are liable to confound them; but carbonic acid is, comparatively speaking, almost innocuous. Carbonic acid, it is true, is somewhat poisonous; it does not merely suffocate like water, or nitrogen, or hydrogen; but it is very much less poisonous than carbonic oxide. It has been found by experiment that an atmosphere containing only 1-100th of carbonic oxide is as fatal to a bird as one containing 1-25th part of carbonic acid."

Barker's Chemistry, New Haven, 1870, p. 237. Under "carbonic oxide." "It is totally irrespirable, being an active narcotic poison, one per cent in the air proving fatal."

Wagner's Jahresbricht, 1874, p. 988. Under "carbonic oxide." "The presence of this poisonous gas was at first, and that justly, urged against the application of water gas; it has, however, been found that at higher temperatures carbonic oxide may be oxidized by means of steam into carbonic acid, so that by employing an excess of steam a gas comparatively free from carbonic oxide can be obtained."

Cooke's Chemical Philosophy, Cambridge, 1875, p. 462. Under "carbonic oxide." "The gas is devoid of odor or taste, is very poisonous, &c."

Schorlemmer, Chemistry of Carbon Compounds, London, 1874, p. 63. Under "carbonic oxide." "It is but sparingly soluble in water, and acts as a strong poison, producing death when inhaled even in small quantities."

In the Annales de Chimie et de Physique, 1842. Third Series, vol. v. pp. 223–268, we find a long article, by M. F. Leblanc, under the title—"Recherches sur la composition de l'air confine." In this extensive treatise, covering some 45 pages, the author, after describing experiments in which it was proved that the actual products of the combustion of a candle, or of charcoal, were far more poisonous than pure carbonic acid mingled with air, continues as follows:

"Although the opinion generally received did not appear to attribute to carbonic oxide, especially when present in small quantity, a deleterious action on the animal economy, I wished to ascertain by precise experiments the part of the influence it could exercise in the effects of the combustion of charcoal. I studied at the same time the action of the gases proto and bicarburetted hydrogen.

"Regarding these latter products, experiment shows that they cannot have any active part in the asphyxiating effects of charcoal. The gas proto-carburetted hydrogen obtained from acetates, and oleflant gas, can be mixed with air, in the proportion of one to two hundredths, without causing any apparent accidents, even at the end of a considerable time. Such is not the case with carbonic oxide. A dose of four to five parts in a hundred of air caused the instant death of a sparrow. A hundreth part of this gas mixed with air killed a bird at the end of two minutes. If the animal is immediately removed from this deleterious influence at the moment of apparent death, it can little by little regain life, but it is often only after some hours that the phenomena of paralyzation disappear.

"We must, therefore, look upon carbonic oxide as a gas eminently deleterious, contrary to the conclusions of Nysten, who had placed this compound among the simply irrespirable gases. This latter opinion, besides, has not been adopted by M. Devergie, in his new Traite de Medecine legale, and in his excellent article on the gases (Dictionnaire de Medecine et de Chirurgie pratiques). Observing that the injection of carbonic oxide into the veins, according to Nysten's experiments, caused the animals to utter cries of pain, and relying moreover on the effects experienced by Samuel Witte (1) after a few inspirations of this gas, M. Devergie does not hesitate to place carbonic oxide among the deleterious gases (2).

"According to the facts here given, we are led to admit that carbonic oxide habitually plays the principal part in the deleterious effects produced by the combustion of charcoal."

And further on, p. 246: "We have pointed out that the toxical property of an asphyxiating atmosphere under these influences should be attributed more particularly to the presence of carbonic oxide ascertained by analysis, since, even when diffused in air to the extent of one part in 100, it forms an atmosphere almost immediately fatal to warm blooded animals; the observed proportions of carbonic acid present, and of oxygen wanting, would not produce nearly such violent effects. It is, therefore, necessary to point out without delay the dangers which may result from the accidental presence of carbonic oxide in air, dangers to which, as far as I know, our attention has not yet been sufficiently called, especially to the influence of such small quantities."

So far we have given quotations expressing the general literature of this subject, now we will turn to the special departments which concern themselves with such substances as we consider "carbonic oxide" to be, namely, Toxicology, the science of the detection and counteraction of poisons; Hygiene, the science of preserving life and health from destructive agencies.

In Werker's "Lehrbuch der praktischen Toxicologie," Erlangen, 1869, p. 81, we find as follows: "Although pure carbonic oxide possesses but little interest in practical toxicology, it has become a matter of great importance on account of the continually increasing number of accidents resulting from charcoal fumes and illuminating gas, in which carbonic oxide occurs mixed with other gases, and of which it forms the specially poisonous constituent. The symptoms, altogether similar, and the condition of the body after death prove conclusively the truth of this latter opinion, although it will not be denied that other admixtures, carbonic acid for instance, may have some effect. Poisoning with pure carbonic oxide can only occur from the careless performance of chemical or physical experiments.

"The gases resulting from the reduction of many metals, (zinc furnaces, etc.), are always more or less mixed with carbonic acid, and resemble charcoal fumes. Three to five per cent. of carbonic oxide mixed with air kills dogs and cats in three to five minutes, birds are specially sensitive, invertebrate animals very little * * The gases resulting from glowing charcoal, coal or peat, contain on an average 2.54 per cent. of carbonic oxide and 24 per cent. of carbonic acid. Poisoning from charcoal fumes is especially frequent in France. Statistics show that of the 17,852 suicides occurring in the years 1848–52, 1,401 were from char-

coal fumes, and 411 from other poisons. That the poisonous character of charcoal fumes is due to carbonic oxide, is proved by the fact that their poisonous nature is retained after removing the carbonic acid by lime water. Illuminating gas which, as is well known, is produced by the dry distillation of coal or wood, and lately, also, of petroleum, varies very much in composition, according to the material employed, the heat applied, and the more or less perfect purification. * * * Marsh gas, like hydrogen, is only irrespirable, but not poisonous. In the case of olefiant gas this is not absolutely established, for, according to some observers, it is said to produce a slight giddiness. Its effect is certainly a very slight one, and on account of the small quantity found in the gas it has probably no influence. We must then consider carbonic oxide as the poisonous principle."

Numerous other statements, similar in effect, are found in the same work; but to quote them all would occupy too much space, and would not add to the force of what we have already transcribed.

Turning next to "Eulenberg's Handbuch der Gewerbe-Hygiene," Berlin, 1876, p. 344, we find as follows: "The effects of carbonic oxide agree with those of carbonic acid only in so far that, with small quantities, there may also be decided symptoms of irritation, which however, far more rapidly than in the case of carbonic acid, pass into general prostration." Then, after enumerating at length the preliminary symptoms, he continues:

"If help is not rapidly rendered there follows prostration, with somnolency, enlargement of pupils, cold perspiration, coldness, loss of feeling in the skin, relaxation of the muscles, difficult breathing, slow pulse, and then death rapidly follows."

On page 347 the author gives a series of experiments on doves and rabbits, with mixtures containing carbonic oxide and carbonic acid mingled with air, in various proportions, from $\frac{1}{4}$ per cent. to $3\frac{1}{2}$ per cent., and then says in conclusion :

"We see, from these experiments, that a slight increase of the amount of carbonic oxide produces, altogether independently of the larger or smaller amount of carbonic acid, the characteristic symptoms of charcoal fume poisoning. Might not the prolonged action of small quantities of this gaseous mixture be of importance in the production of pulmonary affections?"

On page 352, the same author says: "For sanitary reasons, on account of the very poisonous properties of carbonic oxide, all processes in which this gas is produced should be very strictly watched."

On page 603 he says: "In the case of illuminating gas, the most dangerous cases are those in which poisonings occur in houses where no gas is consumed, and where it has entered only in consequence of leaks from mains in the streets. Remarkable cases of this kind which were mistaken even by physicians for typhoid cases, have been described by Pettenkofer. Die Bezrehung der Luft zur Wohnung, &c., p. 87. Relations of air to our dwellings."

M. G. Tourdes, whom we shall have occasion to quote presently in another connection, has published a pamphlet entitled "Relation Medicale des Asphyxies Occasionees á Strasburg par le Gas de l'eclairage."

The incident here related and discussed was the poisoning (resulting fatally in several cases) of an entire family, caused by a leak from a pipe conveying water gas.*

Devergie, in his Medecine Legale, Paris, 1852, vol. iii., p. 82, after quoting the experiments of Nysten on men and animals, says:

"These experiments plainly show the deleterious action of carbonic oxide, and the following, which was made and reported by Samuel Witte (Bibl. brit. sc. et arts, lxi), leaves no doubt in this regard." He then describes the experiment, at the end of which he says: "The usual methods resorted to in cases of asphyxia remained without avail. He was then treated with oxygen gas, which brought him back to life."

On turning next to the immense work which bears the modest title: "A handy book of Forensic Medicine and Toxicology," by Woodman & Tidy, London, 1877, we find, on page 557, as follows: "Carbonic oxide, when respired, passes freely into the lungs, as much as four per cent. being found in the blood of animals exposed for from ten to twenty-five seconds to an atmosphere containing ten per cent. of this gas. When absorbed by the blood it combines with the hæmoglobin. * * * * * The poisonous action of carbonic oxide was noticed by Guyton Morveau in 1802, and by Sir H. Davy in 1810. * * * * * Mr. Higgins, of Dublin, Tourdes, Leblanc and Letheby have also experimented with it. Tourdes proved that one part of gas in seven of air killed rabbits in seven minutes—one in fifteen in twenty-three minutes, and one in thirty in thirty-seven minutes."

* See quotation from Letheby.

"Leblanc and Dumas' experiments show that air containing one per cent of the gas will kill a dog in one and a-half minutes, and that birds die instantly in an atmosphere containing five per cent. Dr. Letheby found in his experiments that air containing $\frac{1}{2}$ per cent of the gas kills small birds in about three minutes; whilst if it contains one per cent, it proves fatal in about half the time. An atmosphere containing two per cent. rendered a guinea pig insensible in two minutes. There were no signs of pain—but the animals fell down insensible, and died at once, either with a slight flutter, hardly amounting to convulsion, or gradually slept to death, as if affected with a profound coma. Carbonic oxide is in short a pure narcotic poison.

"The large quantity of carbonic oxide in water gas (often 34 per cent) would render its employment dangerous as an agent of illumination."

On page 557 of the same work we find as follows:

"In London gas the amount of carbonic oxide varies from five to seven per cent; light carburetted hydrogen, 40 to 45 per cent; and olefiant gas, three to four per cent. There is little doubt that carbonic oxide is the most actively poisonous of the gases present.

"Indeed, some have stated that it is the only poisonous body, (M. Tourdes). But it is more than probable, as Dr. Taylor suggests, that the various hydrocarbons present have also a noxious influence. It is curious, however, that in a very dilute state, pure carburetted hydrogen does not appear dangerous to health, inasmuch as the miners breathe it continually without any apparent ill effects resulting."

The various quotations given thus far make it, we think, abundantly manifest that, in the opinion of the standard writers on chemistry, as expressed in their publications, "carbonic oxide" is one of the most virulent and dangerous gas poisons, the presence of which even to the extent of a few per cent. in the air of a room renders it utterly unfit for breathing and often even fatal.

In face of this, however, we have the fact that certain authors have made experiments with this gas as an anæsthetic, and have written papers about it in this character, and have compared its effects with those of chloroform and other anæsthetics; and have even given it, in some of their statements, a preference to chloroform as an anæsthetic agent.

Now this statement of the case, which, moreover, is literally correct, would certainly convey the impression that the dangerous properties, as stated by the authors whom we have quoted, had been overestimated or exaggerated.

Before forming a judgment, however, it will be safest for us to refer to the original publications of these gentlemen, and see for ourselves exactly what they do say on the subject.

Thus, in the first place, we have an article on the anæsthetic action of gases.—Carbonic oxide, by Dr. Ozanam, published in the Archives "Générales de Médecine, Paris, 1857, fifth series, vol. ix, page 159." This article covers about twenty pages, and we must therefore content ourselves with a few extracts, so selected, however, as to give the character of the whole publication.

In the first place, he announces the theory on which his experiments were based, in the following words:

"The more carbon bodies contain, and the more easy their elimination, the stronger must be their anæsthetic property."

Then, after some general remarks and a description of the method used in preparing the gas, he continues:

"Our experiments and observations amounted to thirty in all, of which twenty-five were made upon rabbits and five upon men; among the latter there are two pertaining to Samuel Witte. We cannot give here a full report of all these cases; it will be quite sufficient to recount in a few words the most important cases.

a. Action of carbonic oxide when inhaled. The phenomena produced by the inhalation of carbonic oxide naturally divide themselves into four periods: Premonitory stage; period of excitement; period of anæsthesia; death or recovery.

First period—Premonitory stage. A fine tube screwed to a bladder full of carbonic oxide was introduced into the mouth of a rabbit, firmly held, and whose nostrils had been stopped up; an assistant pressed on the bladder, and the animal forced to breathe by its mouth, inhaled the gas mixed with atmospheric air.

During the first five or six inspirations the animal does not make the least effort; it is motionless, stunned, as if it were under the impression of some danger which it suspected, yet did not know, and of whose violent effect it was not yet conscious.

I notice this stage, because it contrasts by its calmness with the active effects of a gas so powerful as carbonic oxide.

Second Period—Excitement. But at the end of fifteen to thirty seconds the scene changes; the animal trembles and attempts to escape. Next these voluntary movements are replaced by strong convulsions, various in their form, contractions, turning back of the head, trembling, &c. This lasts from one to four minutes, according to the vigor of the subject, and according as to whether the gas is applied continuously or intermittently.

Third Period—Stupor. The convulsive stage is quickly followed by the period of collapsus or stupor. All motion ceases, the body falls down as an inert mass, the head hangs, the eye is wide open, the pupil dilated, sight almost gone, the four limbs paralyzed, the urine flows involuntarily, the heart beats grow slower (from 180, the normal figure, to 100), respiration also grows slower, it falls to 60, to 40, while in the normal state it is about 100 respirations per minute.

If the inhalation is continued, the act of respiration becomes still less frequent; it only occurs every five or ten seconds, by a general and sudden effort resembling hiccough. But prolonged to this stage the anæsthesia becomes dangerous, and must be closely watched, since the inspiratory nerves are almost paralyzed, and the state of apparent death approached.

The pulse and the state of the respiration are then the surest guides to be followed in order to regulate the effect of the gas. The less frequent they become the greater the danger.

All the phenomena just described take place in a space of time varying from one to six minutes, according as to whether we proceed in a continuous or in an intermittent manner.

Fourth Period—Recovery or Death. *a.* Recovery.—The inhalation is stopped, the animal left to itself. For one to three minutes the anæsthesia remains complete; one could believe the animal dead, were it not that auscultation still reveals the enfeebled beating of the heart and some occasional efforts at respiration. Soon regular life begins again, respiration is re-established; the heart gradually regains its normal figure, and even passes it a little (from 10 to 15 pulsations). At the end of from two to four minutes sensibility returns to the ears, the skin is still insensible. The animal rises to its fore feet; its hindquarters are still paralyzed. At the end of six minutes one can still, in a large majority of cases, run a limb entirely through with a stylet without causing a sign of pain. After 8, 10, 14 minutes, according to the subject, and the degree of anæsthesia, the animal returns to its normal state.

B. Death.—The passage from stupor or apparent death to real death is sudden and unexpected, resembling in this respect sudden death by chloroform. The heart and respiration, already much enfeebled, are suddenly and forever arrested. In one case death resulted after two minutes inhalation of the gas; but a thing worthy of remark in the course of our experiments, a rabbit submitted to chloroforming died in a shorter space of time ($1\frac{1}{2}$ min.)

Action of Carbonic Oxide on Man. Can carbonic oxide be inhaled by man? Everything points to the belief that it can, above all if care be taken at the same time to breathe a certain quantity of atmospheric air. Without doubt extreme caution is necessary; but the 25 experiments which we made, and of which several have been repeated upon the same animal, show that the use of this gas is not so dangerous as was formerly believed, since we have but one case of death among animals so delicate as rabbits.

As affording valuable insight into this question, we give here from Orfila (Toxicologie, vol. i, p. 552, 1843), the two experiments made by Samuel Witte on himself.

Experiment 1. In the first Samuel Witte experienced convulsive trembling and vertigo, with an almost complete suspension of sensibility after two or three inhalations of the gas. Languor, cephalalgia, and a state of weakness followed these phenomena.

Experiment 2. In the second experiment he almost instantly fell backwards, deprived of motion, pulse and sensibility, after making three or four strong inhalations, having first emptied his lungs. The breathing of oxygen gas was followed by better effects.

He still, however, experienced a convulsive agitation and a very severe headache. It was some time before he recovered sight, and he was a prey to nausea, vertigo, and to alternations of chills and fever. He had finally a great inclination to sleep, which was broken and feverish.— Biblioth. Britann. des Sciences et Arts, t. lxi.

We notice again in these interesting facts the two periods of excitement and of collapse proper to anæsthesia; the insensibility also, as well as the two violent effects of the gas when it is respired pure, as in the second experiment.

From this we are justified in concluding that carbonic oxide can, with precaution, be respired by man, that it also produces anæsthesia in this case, and that by mixing atmospheric air with it its strength and effect can be regulated at will."

After this follows a description of experiments on the local application of this gas, and other matter not related to our present subject; but what we have above quoted is every word that this author states in reference to the action of carbonic oxide on man.

This, taken in connection with his earlier statement, that 'our experiments amounted to thirty in all, of which twenty-five were made upon rabbits and five on men; among the latter there are two pertaining to Samuel Witte," is certainly, to say the least, very curious. Of our five experiments two are quoted from another writer, and the remaining three are passed over in silence or were only local applications of the gas to diseased surfaces. The justice of the conclusions drawn from such data may well be questioned by any one who does not, like M. Ozanam, enter upon the subject with a ready-made theory which he desires to support. The facts related by this author are, however, valuable, and give a very different complexion to the subject from that which appears in certain general references to his work which we have not met with in more than one publication.

Turning next to the Comptes Rendus, 1857, t. xliv, p. 96, we find an article entitled "Memoire sur l'action anæsthetique du gaz oxyde de carbonne, par M. G. Tourdes."

Here we encounter, near the beginning, a most encouraging phrase, for the author, from whose other publications (pamphlet on the Strasbourg poisonings with water gas), and his experiments, quoted by Woodman and Tidy, we should hardly expect such an opinion, says: "The two fundamental facts are the harmlessness of the gas and its anæsthetic action."

That this is, however, only a careless form of expression, very soon appears, for a few paragraphs further he goes on: "When we prolong the action of the gas the animal succumbs. It is necessary to arrest it as soon as the anæsthesia is complete. Death may be sudden, with cries and convulsions; but more frequently it is peaceful. The transition from sleep to death is insensible, respiration is arrested, the carbonic oxide seems to act by paralyzing the muscles of respiration. * * * In establishing the anæsthetic action of carbonic oxide it is a duty to point out at the same time the dangers which result from the gaseous form and difficulty of application of this agent, so as not to take the responsibility of the accidents which will occur one of these days." This seems an unkind way of referring to a "harmless anæsthetic," whose only "difficulty of application"

seems to be the trifling one that during its administration "the transition from sleep to death" may be "sudden" or may be "insensible;" but is too probable to make the author willing "to take the responsibility of the accidents which will occur" if it is used.

It would seem, therefore, that even these authors who have been referred to as having proposed and used carbonic oxide safely as an aæsthetic agent upon man as well as upon lower animals, and who have compared the symptoms to those of chloroform, do not encourage its general application very strongly when they are directly consulted and fully quoted, but leave us with the same old impression derived from the chemical literature of the subject, that carbonic oxide is a very dangerous gas poison of which we should beware.

It has, however, been said, that granting this, still ordinary coal gas is also a poison, and that the substitution of one poison for another is matter of no practical moment to the people who fall victims to either, and still less to those who escape both.

Now, in reply to this, we would, in the first place, call attention to the very decided opinion expressed incidentally by some of the authors already quoted, and founded on extended experiments, to the effect that the only practically poisonous constituent of coal gas is its five to seven per cent. of carbonic oxide.

Next, we would ask attention to a few other quotations of statements directly bearing on these points.

Thus, Eulenberg in his handbook of Technical Hygiene (or hygiene in connection with manufacturing processes, &c.), on p. 38, declares hydrogen to be perfectly harmless.

Werker, in his Toxicology, does not mention hydrogen at all among poisonous substances.

Miller, in his Chemistry, p. 41, says: "Pure hydrogen, though it cannot support life, is not poisonous, and when mixed with a certain proportion of air has been breathed for some time without inconvenience."

Such quotations might be indefinitely multiplied, but it is, we presume, accepted on all hands that hydrogen is not a poisonous gas.

Passing next to Marsh Gas.

Miller, in his Chemistry, vol. ii., p. 236, says that it is "not injurious to life if diluted with air."

Leblanc, in the Ann. de Chim. et de Phys., third series, vol. v., p. 239, says that "marsh gas and olefiant gas are not injurious."

Eulenberg. Handbuch der Gewerbe Hygiene, already mentioned at p. 368, says: "The action of marsh gas on the animal organism is in no way injurious to health, if headache, dizziness, fainting and similar effects are produced, it is certainly mixed with carbonic oxide. In coal mines such mixtures not unfrequently occur. According to the amount of carbonic oxide present, the workmen will be more or less affected with symptoms which never occur with pure marsh gas. Rabbits can remain in an atmosphere containing five per cent. of marsh gas for twenty minutes without showing anything abnormal."

According to Richardson, seventy to eighty per cent. of the gas is necessary to produce an anæsthetic sleep. In experimenting with animals this effect was not observed.

Fowne's Chemistry, Philadelphia, 1869, p. 169. Under marsh gas. "It is not poisonous, and may be respired to a great extent without apparent injury."

Hermann, Berlin, p. 275. "Marsh gas has been proved to be indifferent."

Leblanc. Comptes Rendus, 1842, t. xiv., p. 868. "But some experiments made on animals demonstrated to me that even a very feeble dose of carbonic oxide may occasion very serious and even fatal accidents. Thus a dose of five per cent. in air will instantly kill a sparrow; a dose of one per cent. causes death in two minutes or more. Marsh gas, on the contrary, in a dose of one per cent. does not produce any serious effect, even in a much greater length of time. Olefiant gas diffused in air to the extent of some hundredths does not produce any ill effects."

ETHANE* ($C_2 H_6$).—Eulenberg, p. 398. This author, after describing four experiments on animals, remarks: "The foregoing experiments prove undoubtedly the anæsthetic action of ethane, in this respect it is the first one of the ethyl compounds known as an anæsthetic. Mixed with a sufficient quantity of air it does no permanent harm, since it does not prevent the blood from absorbing oxygen." This last remark is made in reference to the observation that carbonic oxide seems to produce its fatal effects by entering the blood to the exclusion of oxygen, whose absorption it thus prevents.

Hermann, p. 276. "Ethylene gas ($C_2 H_6$), I have proved on myself to be mildly intoxicating, almost like laughing gas."

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* We introduce a reference to ethane here, not, of course, because we regard it as a constituent of coal gas, but to provide for future reference, and to make this class of citations complete.

From all this it would certainly seem to be very evident that, in the opinion of competent judges and authorities, the constituents of ordinary illuminating gas, other than carbonic oxide, bear no sort of comparison with it in poisonous properties, even if they have any serious ill effect at all.

To sum up then, in a few words, it seems to us that as far as the weight of authority goes, carbonic oxide stands condemned as a rank poison, very exceptionally dangerous as compared with the other constituents of illuminating gas.

This by no means deprives those gentlemen who think differently of their right to their own conclusions; but, on the contrary, tends to establish their claim to originality, and show that their ideas are exclusively their own, and have not been anticipated by any prior publications.

There still, however, remains another standpoint of observation from which this question, in its practical application to water gas may be viewed with propriety.

This, I think, I can best express by describing in the first instance a parallel but hypothetical case.

Suppose that the safety matches, made with amorphous phosphorus, were first invented and introduced, and that the question were then asked about the desirability of introducing "parlor matches."

We might say, safety matches may cause loss of life by fire, or, perhaps, if not made with strict care might be to some degree poisonous; but the parlor matches are much more likely to cause a conflagration and are much more poisonous—shall we, therefore, discourage the parlor match? Prudence certainly says: don't add to the existing risks to life and property; but a larger range of view might disclose such considerations as these. The risks in either case are very small. Both articles are harmless under normal conditions. The knowledge of danger will make people more careful, &c.

If, then, there is some decided gain to be expected by the public at large from the parlor match, an enlarged philanthropy may even advise that the additional risk should be run and "the greatest pleasure of the largest number" secured, even at the cost of a few more houses consumed or children poisoned.

When, therefore, it shall appear that the introduction of water gas is to benefit the world at large, it may well be urged that the benefit is worth what it costs in added risk.

Apropos of the match illustration I have a suggestion of encouragement to those who are engaged in developing the

water gas manufacture, which it gives me great pleasure to make, for I really have no interest on either side and entertain the most friendly feelings for those engaged in promoting water gas. My suggestion is this :

The safety match was put in the market at least twenty years ago, and yet the inflammatory and poisonous parlor match still triumphs, thanks to its superior convenience.

Nitro-glycerine entered the world heralded as it were by a holocaust of some hundreds of human beings, and is still the very type and example of destructive agents; yet, on account of its convenience, economy, and efficiency, it is to-day the explosive of the world in all engineering applications. It is also practically less destructive than gunpowder, because, among others things, a sense of its ability to destroy causes it to be handled with caution. The moral hardly needs statement. When water gas is a successful manufacture, its capacity for evil, when misapplied, will neither check its application nor render that application practically safer by being depreciated.

I will take advantage of the present opportunity to correct a mistake of my own, which has only just come to my knowledge. In my report on the Harrisburgh gas, published in this Journal, of Nov. 2, 1877, I gave the increase in amount of carbonic acid, produced by the combustion of a given volume of that gas, as 70 per cent. greater than that produced by the combustion of an equal volume of ordinary coal gas. On referring recently to my original notes, I find that this 70 should have been 50. The number 70 occurred as the result of one of the preliminary calculations, and was accidentally copied into my report.

This mistake is one of those which one would believe impossible if they did not occasionally happen.

Fortunately, large as the error is, it does not involve anything affecting the general conclusion reached; whether a water gas produces 50 or 70 per cent. more carbonic acid than an average coal gas, is simply a question of degree.

One of my critics seems to suppose that the relative quantities of carbonic acid from coal and water gas depend upon the products of combustion of marsh gas and of carbonic oxide. Here he is himself in error.

The large yield of carbonic acid in water gas comes, not from its containing carbonic oxide as a substitute for marsh gas, but from the large percentage of illuminants which it contains, and which, being rich in carbon, yield excessive amounts of carbonic acid. Thus olefiant gas yields twice as much carbonic

acid as marsh gas, and other members of the olefine series progressively, three, four, five, &c., times as much, acetylene; also, pure benzole, six times as much, and the various members of the paraffine series such amounts as are indicated on page 68 of the present volume.

But it may be suggested, if the illuminants are the cause of this increased yield of carbonic acid, must it not be more than cancelled by the gain in candle power.

This does not, however, follow. The very interesting record of results, by Frankland and Thorne, shows that where marsh gas is replaced by carbonic oxide a very much larger proportion of an illuminant is needed to produce the same candle power. This drawback is, therefore, inherent in any gas which replaces marsh gas by carbonic oxide.

It is worthy of note, also, that very rich, or high candle power coal gas will have a similar drawback, as compared with a poorer one, and will tend to vitiate the air of rooms to a greater degree.

It is no practical answer to this objection to say that, with a higher candle power, less gas in proportion is used. This is not true within the range of moderate variations, such as are now considered (16 to 20 candle power.) The consumer, with a richer gas, rejoices in his superior light, and turns on an extra burner to realize his advantages more thoroughly.

We are not referring to extreme cases, or maintaining that in a nearly pure marsh gas there would be a better condition of affairs in this respect than in a rosin gas; but, simply, that within an ordinary practical range, high candle power may not always be an unmixed advantage.

As regards the actual fact of the production of carbonic acid, by coal gas and water gas on burning, I made the simple experiment of exploding known volumes of coal gas and water gas,* and determining the volumes of carbonic acid actually produced, and of oxygen actually consumed in that operation.

Thus, 100 measures of the illuminating gas from coal, supplied by the Hoboken Gas Company, as it comes from the burners in my laboratory, yields 64.945 measures of carbonic acid, while 100 measures of waterg as, supplied by the Municipal Company of New York, as it comes from a burner in the School of Mines, yields, on combustion, 99.93 parts of carbonic acid.

The amounts of oxygen consumed are about the same, in each case, being in fact—

Hoboken gas 133.375...........per 100 vols. of gas.
Municipal gas 151.24...........per 100 vols. of gas.

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* By water gas I, of course, intend the illuminating mixture so called.

The reason of this large yield of carbonic acid from water gas, as I have already stated, is to be sought not in carbonic oxide, but in the excessive amount of illuminants which water gas requires to bring it up to a good standard.

Thus, while a coal gas with 6 per cent. of illuminants will give 16-candle power, a water gas, with 18 per cent. of illuminants, will only give twenty-two candles, or, in other words, require 300 per cent. increase of illuminants for 40 per cent. increase in light. This is necessary, because as Frankland's article already cited shows, while marsh gas is not an illuminant, and contributes nothing to the production of light, yet carbonic oxide is a sort of negative illuminant, or absorbent of some 20 per cent.

The following analyses of some water and coal gases will show these and some other curious relations.

Analysis of Municipal gas, made in June, 1877, in which the presence of benzine or paraffines was first noted by me.

Carbonic acid	.21
Oxygen	.14
Benzine vapors and like illuminants	1.14
Olefiant gas and like illuminants	15.12
Carbonic oxide	26.18
Hydrogen	27.29
Marsh gas	25.43
Nitrogen	4.45
	99.96

In this and other cases I use the popular word benzine to indicate, in a general way, a mixure of paraffines, such as the benzine or petroleum naphtha represents. I have since abandoned the use of this word to avoid confusion with benzole, $C_6 H_6$, which is, of course, reckoned in an ordinary analysis among the olefines, or illuminants. Of course no one supposes that benzole is an olefine; but, as for practical purposes, its behavior in an illuminating gas is indentical with an olefine, this loose way of indicating the group of bodies absorbed by Nordhausen acid or bromine is not objectionable.

ORDINARY COAL GAS.

	RUSSELL.	A. WURTZ.		W. D. THOMPSON.
Carbonic oxide	4.167	12.9	6.6	5.62
Carbonic acid	1.950	.3	3.6	.46
Oxygen	.139	——	——	H_2O 2.48
Olefines	5.504	3.8	6.4	3.86
Hydrogen	45.847	50.2	45.6	45.43
Marsh gas	40.948	32.8	34.9	39.93
Nitrogen	1.445	——	2.7	2.22
	100.000	100.0	99.8	100.00

It is a curious circumstance that the water gas shows less hydrogen, as a rule, than the coal gas.

MUNICIPAL GAS, DEC. 12. 1877.

Carbonic acid	.371
Oxygen	1.021
Olefines	17.363
Carbonic oxide	27.893
Hydrogen	23.487
Marsh gas	24.612
Nitrogen	5.235
	99.982

In this analysis the fraction of a per cent. of paraffines was not removed, and the hydrogen and marsh gas members are, therefore, in error to a corresponding amount.

HARRISBURG WATER GAS, COLLECTED JANUARY, 1878.

Carbonic acid	3.691
Oxygen	.421
Olefines	12.376
Carbonic oxide	26.190
Hydrogen	31.865
Marsh gas	21.631
Nitrogen	3.788
	99.962

Paraffines not determined in this particular case, and thus hydrogen and marsh gas figures are subject to correction.

I have lately heard my analyses criticised because they did not foot up 100.

This is a matter of taste, however, in which I claim the right of pleasing myself. These determinations involve a considerable amount of calculation. I have carried my figures out in them to the third place of decimals, and neglected all beyond. This causes a slight deficiency in the summation of results. It would be easy enough to "pad" the figures to a round sum, and even if this were all done in one item it would hardly introduce an error equal to that which probably exists from other causes, and would certainly be of no practical importance whatever. For my own part, however, I think that the actual numbers look just as well, and are no less honest than a round sum obtained by making .286=.290, or the like.

APPENDIX E. PAPER 3.

COMMONWEALTH OF MASSACHUSETTS,
State Board of Health, Lunacy and Charity,
DEPARTMENT OF HEALTH, STATE HOUSE, BOSTON, May 1, 1883.

In reply to your letter of April 26th as to cases of death from inhaling of illuminating gas, I will say that I have written to Dr. Draper, who is the medical examiner for one of the Boston districts, and he replies that he has made two autopsies in cases of death from inhalation of illuminating gas, and another in which the same cause was probable. In all, the gas inhaled was coal gas. I send you a copy of the report of autopsies, taken from Dr. Draper's account in the Boston City Hospital Reports, vol. iii.

It would seem that a general introduction of water gas would have the following objection, as a matter of public health : It contains a far greater quantity of carbonic oxide gas than illuminating gas from coal, and hence more dangerous. (It is much more inodorous, and hence more dangerous.) Thus far but little can be judged of its fatality from observation and experience, since it has nowhere been introduced on a large scale.

You will find an article upon this subject in the Transactions of the American Public Health Association, vol. iii, by Dr. Edward S. Wood.

Yours truly,

SAMUEL W. ABBOTT.

APPENDIX E. PAPER 4.

LABORATORY FOR ANALYTICAL CHEMISTRY, No. 46 MEETING STREET,
CHARLESTON, S. C. May 3, 1883.

In response to your favor of the 30th ult., this day at hand, I beg to state that I have not changed my views from those expressed in the pamphlet forwarded to you by the same mail.

Yours very truly,

CHARLES U. SHEPARD, JR.

WATER GAS IS POISONOUS.

[Extract from the Journal of Gas Lighting, Water Supply and Sanitary Improvement. London, May 28, 1878.]

WATER GAS.

In the Journal of the 7th inst. we published a report made by Professor Wurtz, on the chemical composition of the gas manufactured at the works of the Municipal Gaslight Company, New York. No doubt many of our readers were surprised on perusing that report, to find that the opinion entertained in past times as to the noxious character of carbonic oxide was entirely repudiated by the writer. We have thought, therefore, that a review of the history and progress of water gas manufacture might be interesting and useful, as bringing to light what the old school authorities really knew and said about the nature and effects of carbonic oxide. That it is present in large proportion in the mixed gases obtained by the decomposition of water with highly heated carbon in well-constructed furnaces is abundantly proved by the document just referred to, though its baneful influence seems therein to be completely ignored.

From the report of Professor Wurtz we find that on a certain day the gas under analysis contained 38.46 per cent. of carbonic oxide. Of course it did, the aim of the water gas maker being to produce this gas, instead of the incombustible article carbonic acid. The accomplishment of this object is that which inventor after inventor labored unsuccessfully to achieve, until the time of the contrivance of the Kirkham furnace; in fact, Kirkham's method was considered a success because of this. No attempt, therefore, is made by the American users of his plan to disguise the presence of the once dreaded poison; knowing as they do that water gas cannot be profitably manufactured without admitting it as one of the constituents of the mixture.

Although it seems ridiculous to remove, by any means, however simple, so large a volume of combustible matter when once formed, yet it is well known that the feeling against it was so strong in France, some years ago, that the Alliance Company, holding the concession for lighting the Hotel des Invalides, being desirous to substitute the Kirkham gas for the coal gas they were then supplying, professed that they would purify it in such a manner that it should contain only two per cent. of this noxious element. Arrangements were made for carrying this plan into effect, but the gas on being analyzed was found

to contain from thirty to forty per cent. of carbonic oxide, instead of the specified quantity. After reading the following report, we can understand why Kirkham's process was so unceremoniously abandoned in France at that time, and why in these days a Frenchman should take the idea to America, instead of trying it again at home.

(TRANSLATION.)

[Report of M. Pelouze, to the Municipal Council of Paris, in the Sittings of June 24 and 28, 1854.]*

"No process, however admirable and promising in other respects, could stand against such serious accusations as these, and, consequently, it was not long before Kirkham's system of gas manufacture was altogether abandoned in France. Its recent revival on the other side of the Atlantic leads us to notice what was done before Kirkham, and what has since been done by others; because there is no doubt that, if the water gas idea becomes for a short time popular again, many transformations of the Kirkham furnace will make their appearance, and claim for themselves the charm of novelty." * * *

In this connection we give the remarks of C. V. Smith, C. E., in the report of his visit to the works of the Municipal Gaslight Company in New York:

"On the 21st day of March, 1876, in company with several other engineers connected with some of our largest neighboring companies, I examined thoroughly into the merits of the process, and although extravagant claims had been made for its economy, they frankly admitted it was not made cheaper than coal gas, but, with the experience gained, it could be in the future. Subsequently, in looking up authorities on water gas, I found in Hughes' Gas Works, 2d edition, 1864, a description of this novel invention credited to and used by M. Gillard, at Narbonne, France, in 1859, about fifteen years prior to Du Motay's alleged discovery. Their patents in this country only cover a few minor details not vital to the process, should any care to avail themselves of it. Hence, we see there is no novelty."—Society of Gas Lighting, 1878, p. 45.

It having been asserted, as Major Gilchrist, before the City Council of Charleston asserted, that water gas was not forbidden in France, a letter of inquiry was addressed to M. Pelouze. The following is his answer:

* That part of this report which is omitted here is given in another part of the Appendix.

(TRANSLATION.)

PARIS, October 15th, 1875.
34 Rue Delaborde.

Mr. JAMES SMEDBERG, San Francisco, Cal.:

DEAR SIR:—You can let Mr. Bartol know, in answer to his question, that there is no law prohibiting Paris from using gas obtained by the decomposition of water.

What follows will explain how such a thing could be supposed.

In 1855 the different gas works for illuminating the city of Paris and its surroundings were united to form one single company, the Parisian Gas Company.

A commission appointed by the Municipal Council of Paris, and the Prefect of the Seine Department, had previously examined the different processes of making illuminating gas. On their report the Municipal Council imposed on the Parisian Company the obligation of making their gas by the distillation of coal, rejecting all other processes, among them that of gas from water. One of the principal reasons for the rejection of this gas from water was, in effect, the presence of a large quantity of carbonic oxide in a gas thus obtained, capable of causing asphyxia, and the formation of explosive mixtures.

By said agreement with the City of Paris, the Parisian Company has the exclusive right to lay their pipes under the streets or public ways; this is equivalent, indirectly, to a prohibition of any other system of lighting which requires subterranean pipes for its distribution.

This regulation does not prohibit any person from lighting his own premises as he may wish, with gas from coal, portable gas, which is carried to the domicile of the user, petroleum, oils, &c., providing they conform to the police regulations.

There is no law or regulation that prohibits the employment of gas obtained by the decomposition of water.

Nevertheless, I repeat it to you, the Parisian Company cannot manufacture or distribute by their pipes any but the gas obtained by the distillation of coal.

Yours, truly.

(Signed) EUGENE PELOUZE,

Director of Gas Co.

In Germany the manufacture of water gas is, I am informed, prohibited by law.

Report of B. H. Bartol to the Committee on Public Buildings and Grounds, United States Senate, of February 7, 1876, pp. 8 and 9.

To show the poisonous quality of Carbonic Oxide, we quote from an article by Prof. Morton, viz:

CARBONIC OXIDE.

"IS IT A HARMLESS ANÆSTHETIC OR A VIRULENT POISON?"

[By Henry Morton, Ph. D., President of the Stevens' Institute of Technology.] *

On page 557 of the same work, we find as follows:

In London gas the amount of carbonic oxide varies from five to seven per cent; light carburetted hydrogen, 40 to 45 per cent; and olefiant gas, three to four per cent. There is little doubt that carbonic oxide is the most actively poisonous of the gases present.

'Indeed, some have stated that it is the only poisonous body (M. Tourdes). But it is more than probable, as Dr. Taylor suggests, that the various hydrocarbons present have also a noxious influence. It is curious, however, that in a very dilute state, pure carburetted hydrogen does not appear dangerous to health, inasmuch as the miners breathe it continually without any apparent ill effects resulting.'

EXTRACT FROM REPORT OF GAS COMMISSIONERS OF CITY OF BOSTON, 1876, PAGE 30. *

"The addition to it, however, of petroleum gas greatly diminishes the danger by imparting to it a very powerful odor."

Von Pettenkofer: Professor of Hygiene at the University of Munich and "Obermedicinalrath," in his Beziehungen des Luft zu Kleidung, Wohnung & Boden, 3d Ed. Brunswick, 1873, (pp. 87, 88,) says:

"Remarkable proof of the permeability of the ground upon which our houses are built, and of their foundation walls, is furnished by the leakage from burst gas pipes in the streets, which every now and then has killed persons asleep in the adjacent houses, even when there were no gas pipes in these houses themselves.

"I know in my own experience cases where in this way in one night often two and three, and one occasion, five persons, on the ground floor, were poisoned by illuminating gas which escaped by a leak often more than twenty feet from the walls of the house, and could never be revived.

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* That part of this report which is omitted here is given in another part of the Appendix.

"The gas, in order to have killed the persons in these rooms must, in these cases, have passed through the body of the street, then through the foundation walls of the house, then through the vacant space of the cellar, and lastly, through the floors of the rooms themselves."

Dr. von Pettenkofer then explains why such cases as the above occur from leaks in the street only in winter, and in summer only from leaks in gas pipes in the houses themselves —not because as suggested by some that air and gases cannot pass through the ground when frozen; but because from the heat in the houses in winter, the air within them becomes heated and rises, and thence the cold air and gases in the earth rush in. The heated house somewhat like chimney draws to itself all the neighboring currents of air. He then continues, p. 89:

"I have known in Munich an interesting case which shows clearly that the air from the ground can bring the smell of gas into a house without there being a trace of the smell in the street itself. In a small room on the ground floor of a palace, which was heated to a high degree, gas was most plainly smelt. The palace itself was not lighted with gas, though there was a gas-pipe through the entrance leading to the court and to the stables. A close examination of this pipe was made but no leak was discovered. As the smell of gas remained in the room, all connections with gas were cut off from the palace and oil lights alone used. It was confidently expected that the smell of gas would then disappear; but it did not. The streets were then opened and the pipes were examined. The pipes were found tight; but something else was also found.

"The palace was so situated that the level of the street, (herfallt) at this point sloped downwards from two sides. At this point, therefore, there was found a water-collector or syphon. It was made of the old style, by which, when the condensed water reached a certain height it ran over into the adjacent ground. The gravel at this point, therefore, had become impregnated, not with gas, but merely with gas water. While the air streamed through the gravel toward the warmed house—that is, while the colder atmospheric air in the street pressed the warmer air in the gravel to the still warmer house, this air became impregnated with the smell of gas, derived from the escaped condensed gas water. The syphon was removed and the smell in the palace totally disappeared.

"I will (p. 90) give another case, of my own experience, of the streaming of air contained in the ground of the street towards

a house. This fell under my own observation; and it shows how the flow of air is often directed to a special locality--to one out of several adjacent rooms.

"About fourteen years ago, in a Bavarian city, in a Catholic parsonage, there lived many priests in the adjoining chambers on the ground floor. One morning the priest whose turn it was to read mass, did not appear; and upon going into his chamber, he was found lying unconscious and fainting. The physician was called. He was at no loss in his diagnosis, and at once declared the case one of 'typhus pernicrosus,' which at that time was prevalent in the city.

"A male nurse, and after him a Sister of Mercy were detailed to tend the patient. After a few hours spent in the sick man's room, both of them had to be taken out, both having fainted and showing the same symptoms as the sick man. Manifestly they were infected with the same kind of malignant typhus; and as the sick priest became worse each hour, his parents were telegraphed to come at once if they wished to see their son before the death for which he had already received supreme unction.

"This message of sadness soon spread through the parochial circle in which the young priest was specially respected and loved. An elderly city matron, despite of the medical prohibition and despite of the danger of infection, would not keep from saying farewell to the good and kind priest. This elderly matron kept an inn, and as soon as she entered the priest room, she exclaimed, 'gas is escaping in this room.' She was answered, that this was impossible, as there was neither gas nor gas-pipe in the whole parsonage. The smell had already struck several, and proceeded in part from the perspiration of the sick man, and in part from the privies. But the old lady had too strong a mind—she refused to admit herself mistaken or to be restrained from removing her clerical pastor, (who had been in delirium, but had improved slightly on being taken to an open window) from this atmosphere and putting him to bed in her inn; although the physician declared the sick man to be on the point of death and incapable of transportation. It would detain me too long to picture the entire romance which followed; but the change of atmosphere had so remarkable a result that the sick man in half an hour after his removal to the fresh air, recovered his consciousness, and would not believe that he had typhus fever. That evening he showed a very good appetite.

"Upon the removal of the sick man all the windows of his room were thrown open and were left open all night to let the fearful infection from him escape. The consequence was most

remarkable. During the night the next door neighbor of the priest sickened in the same way. The attending physician saw in this the indisputable confirmation of the diagnosis, which had been denied the day previous, of *typhus perniciosus.* Yesterday one priest, the nurse and Sister of Mercy. To-day another priest—the one had evidently been infected by the other. But the good city matron had already applied to the gas office, and upon the opening of the frozen street, it was found that the gas pipe had burst about twenty feet (German) from the outside wall of the parsonage. It was repaired, and the symptoms of typhoid fever disappeared. * * *

"The clerical gentleman has given me this story himself, and permits me to give his name on the condition that I mention with proper praise her who saved his life. The place was Augsburg—the clergyman is Mr. Jacob Turk, now the Royal Clerical Counsellor, a court-cannon and professor to the Royal Cadet-corps in Munich. The sensible and energetic woman was mine hostess of the "Three Moors" in Augsburg, the aged Madame Deuringer, who died about six months ago." * *

I can tell also another story like this—only from Munich, not Augsburg.

(This is found in Anhang 12, p. 114, and is very similar.)

"The movement of gas from the ground into our houses teaches us * * that we are very short-sighted when we hold that our uncleanly neighbor can at the most poison our water. He can also poison the air in our ground, and this is the more dangerous, as the air diffuses itself more and is more movable than water. If I can convince you of this fact, my lecture here has not been in vain."

Bear in mind that in these cases it was coal gas which caused the above. If it had been water gas, about five to six times more poisonous, even the sensible exertions of mine hostess of the "Three Moors," would hardly have saved the Reverend "Royal Clerical Counsellor."

Dr. Hermann Eulenberg, in his "Handbuch der Gewerbe-Hygiene, Berlin, 1876, p. 352, speaking of carbonic oxide, says :

"In a sanitary point of view, all processes in which carbonic oxide enters should be watched with the utmost closeness, on account of its very poisonous qualities. To these chiefly belong all chemical operations which produce carbonic oxide. * *

In places where people live, carbonic oxide comes from illuminating gas, leaking from imperfect pipes. * *

Velpeau, in 1865, first called attention to the observation of Carret upon a new epidemic in Savoy, which was called

'meningetis cerebro-spinalis, typhus cerebralis, and febris, remittens gravis,' which however, proved to be only the intoxication of the carbonic oxide which escaped from the iron stoves. * *

That (p. 353) carbonic oxide can produce extremely grave and serious illness, is most thoroughly established (hinreichend begrundet). Carbonic oxide poisoning have even by physicians been mistaken for typhus and similar diseases. It is, therefore, of the greatest importance to hunt out this injurious factor every where and to avoid its deleterious effect."

Again, p. 602, "with illuminating gas, the most dangerous cases of poisoning are those which have occurred in houses where no gas was used; but where the gas has forced itself in the houses from leaks in the gas pipes in the streets."

Read, pp. 601, 603.

LABORATORY FOR ANALYTICAL CHEMISTRY,
20 Broad Street (up stairs),
CHARLESTON, S. C., July 24, 1880.

Maj. HENRY E. YOUNG, Charleston, S. C.:

In compliance with your request, I beg leave to submit herewith my objections to water gas.

It is dangerous.

According to the analysis, by their own chemist, of the commercial water gas manufactured, according to the "Tessie du Motay" process, by the Municipal Gaslight Company of New York City, it contains about 28 per cent of carbonic oxide gas.[1]

The amount of carbonic oxide in the ordinary coal gas may be stated as about 6 per cent.[2]

In fact the principal difference—from a hygienic standpoint—between the two gases lies in the larger content of carbonic oxide in water gas and of marsh gas (or light carburetted hydrogen) in coal gas. In the treatment of the intensely heated carbonaceous matter with steam, it is the object of the manufacturer of water gas to produce as much as possible of carbonic oxide—a combustible gas—to the end of diminishing the quantity of carbonic acid gas, which is incombustible. There is no feasible method of subsequently removing the carbonic oxide from the gaseous product, desirable as this step is regarded by all.

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[1] Report of Professor Henry Wurtz to Charles D. Frankland, President of the Municipal Gaslight Company of New York, March 4, 1878. Journal of Gas Lighting, Water Supply, &c., May 7, 1878.

[2] Chemistry, inorganic and organic, Bloxam, p. 141. Encyclopedia of Chemistry, vol. 1, p. 994. American Gaslight Journal, March 2 and 16, 1878.

"Carbonic oxide gas is not only unfit for respiration, but it is deleterious. Not only can it suffocate, it poisons."[3]

"One hundredth part of this gas (carbonic oxide) mixed with pure air, renders it almost paralyzing for warm-blooded animals."[4]

"Carbonic oxide is a gas of so poisonous a character that, according to Leblanc, one volume of it diffused through one hundred volumes of air totally unfits it to sustain life."[5]

"Warm-blooded animals soon die in an atmosphere containing carbonic oxide, even a slight admixture, as low as one per centum, being sufficient (to produce that effect)."[6]

The small content of carbonic oxide in coal gas, imparts to it its poisonous properties, since the more abundant constituents (hydrogen and marsh gases) are simply irrespirable, *i. e.*, non-life-sustaining, but are not poisonous, and the authorities seem agreed in estimating the deleterious effects of coal gas by its percentage of carbonic oxide.[7] But as water gas contains four to five times as much carbonic oxide as coal gas, it is not strange that numerous deaths have resulted from the substitution of the former for the latter, or that the use of an illuminating gas possessed of such deadly properties has been expressly forbidden in countries where the preservation of the citizens' life is a matter of serious governmental concern.[8]

The unignited escape of water gas for a few hours from an open burner of the ordinary size into a close sleeping apartment of common dimensions, would introduce sufficient carbonic oxide to jeopard, if not destroy, human life, since (as before quoted) the contents of this poisonous gas has only to reach 1 per cent to prove deadly to an unconscious sleeper.

Again, the products of the combustion of water gas are more deleterious than those of coal gas. When equal volumes of both are burnt, water gas produces about fifty per centum more carbonic acid gas.[9] Consequently, with the same consumption of water gas and coal gas, the atmosphere of an apartment would be much sooner vitiated by the use of water gas.

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[3] Traité Élementaire Chémie Médicale, Ad. Wurtz, vol. 5, p. 239.

[4] Chimie appliquée a la Physiologie, a la Pathologie et a l'Hygiène Gautier, vol. 1, p. 14.

[5] Chemistry hiorganic and organic. Bloxam, p. 118.

[6] Lehrbuch der Experimentallen Toxicologie Herman, p. 102.

[7] Handbuch der gurichtlichen chemie. Sonneuschein, p. 299. Handbuch der Toxikologie, Huseman, p. 657. Lehrbuch der praktischen Toxikologie, Werber, p. 82.

[8] Report of M. Pelouze to Municipal Council of Paris, June 24 and 28, 1854, Journal of Gaslighting, &c., May 28, 1878. American Gaslight Journal, June 16, 1880.

[9] "Carbonic oxide," Prof. Henry Morton, American Gaslight Journal, March 2 and 16, 1878.

Perhaps the most terrible calamities arising from the inhalation of illuminating gas occur in houses into which the service pipes have not been introduced, but into which the gas finds its way through drains or other openings from a defective main, and where the true cause of the trouble is at first passed over owing to the non-consumption of gas on the premises.[10] That under such circumstances the consequences would be much more serious with water gas than with coal gas, follows very naturally from my previous remarks on carbonic oxide. In fact wide spread disorders which were at first regarded as epidemics of cerebro-spinal meningitis and typhoid fever have been traced to the presence of carbonic oxide in the atmosphere.[11]

It remains to be proven that water gas is cheaper than coal gas.

The claim of the advocates of water gas rests mainly on their assertion that it can be produced at a much lower cost than coal gas. The cost must chiefly depend on the prices of anthracite coal and naphtha, which until recently were sold at such low rates that in the cities near the coal centres there appeared to be some ground for the assertion. But when, this spring, the prices of these articles had somewhat recovered to what may be regarded as their legitimate values, we find the Municipal Gaslight Company of New York City (the most prominent "Tessie du Motay" concern in the country) actually demanding $2.25 per one thousand cubic feet, notwithstanding their former boast that they would always be fully recompensed with $1.50 for the same quantity. [12]

It has been shown that the manufacture of water gas is necessarily attended with a very considerably greater waste of energy than is involved in the production of coal gas ; that one pound of coal in the products of the coal gas process affords two and a half times as much potential energy (*i. e.*, heat units) as the same amount of coal converted into water gas ; and "that one cubic foot of coal gas would generate more than twice the heat of one cubic foot of water gas." [13]

Naphtha, which enters into the manufacture of water gas to the extent of about six gallons to the one thousand cubic feet,

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[10] Gewerbe Hygiene, Enlenberg. p. 352 ; Beziehungen der Luft zu Kleidung, Wohnung und Boden von Pettenkoffer, p 87.

[11] Gewerbe Hygiene, Enlenberg, p. 602.

[12] Letter of Prof. Benj Silliman, Yale College, July 17, 1880.

[13] "Waste of energy in the production of water gas." Lecture by E. Vanderpool, before Soc. of Gaslighting, Oct. 9, 1879.

is a dangerous commodity, whether for transportation or storage, and could not fail to cost very much more in this city than in Pennsylvania and other localities near the oil regions.

Very respectfully your obedient servant,

CHARLES U. SHEPARD, Jr.

LABORATORY FOR ANALYTICAL CHEMISTRY,
20 Broad Street (up stairs),
CHARLESTON, S. C., August 12, 1880.

Major HENRY E. YOUNG, Charleston, S. C. :

DEAR SIR : There are several very surprising statements in the communication of Henry A. Mott, Jr., Ph. D., &c., &c., which appeared in the "News and Courier" of the 28th ult., and to which you have now called my attention.

Dr. Mott repeatedly asserts in his letter that the commercial water gas is "fixed;" the result of passing the mixture of the two gases (the "body gas" and naphthous vapor) through retorts "where they both unite and form a fixed gas."

It is to be inferred that by fixation he means the establishment of a chemical union between these gaseous mixtures. If that be the case, it is very strange that this mysterious "tertium quid" does not appear among the definite chemical compounds and simples of Dr. Henry Wurtz's analytical tables. That gentleman has published the following analyses of the water gas furnished by the Municipal Gaslight Company of New York :

	Per Cent.	Per Cent.
Hydrogen gas	38.05	38.20
Marsh gas	11.85	15.82
Carbonic oxide gas	29.40	27.14
Carbonic acid gas	0.10	0.10
Oxygen gas	0.10	0.10
Nitrogen gas	3.71	3.35
Olefines (vaporized)	9.29	9.29
Paraffines do.	7.50	6.00

All the above mentioned bodies are as familiar, especially in the case of carbonic oxide, as arsenic. Where is the "fixed" gas, and of what does it consist?

If "fixation" does take place, it must be of a very weak character, for it did not interfere with Dr. Wurtz's determination of the several constituents ; nor does he appear to have recognized any chemical union between them ; nor would it retard the deadly effect of one of the chief ingredients upon animal life.

To assert that "improved apparatus for storing naphtha has eliminated all danger of explosions from this source," would be only equalled by claiming that improvements in the construction of powder-magazines had rendered gunpowder a safe commodity.

Dr. Mott ignores entirely the difficulties and dangers inseparably connected with the transportation and use of naphtha.

Carbonic oxide does not appear to constitute a "fluctuating percentage" in water-gas as manufactured by the "Tessie du Motay" process, and as examined by the chosen chemist of the Municipal Company of New York.

It would seem to be quite uniformly present to the extent of about 28 per centum, *i. e.*, four or five times as much as is contained in coal gas!

Dr. Mott does not claim that water-gas undergoes so binding a "fixation" as to lose, entirely, the poisonous properties of its constituents. He is even disposed to separate by twenty minutes the completion of the toxicologicial action of the two illuminating gases, and affects to regard with favor the (acknowledged) earlier fatal effects of the water-gas! That a suicide or condemned person should choose water-gas in preference to the more painful, but speedier (though not surer) rope or axe, is not to be wondered at; but that an intelligent man should trifle with a question of such momentous consequences to the innocent public, is, at least, very surprising.

Not only will water-gas kill more rapidly than coal-gas, but very much so. And what is to the point—the effect of escaping unignited water-gas on a sleeper in a close apartment is so speedily deadly, that the chances are largely in favor of his being found dead in the morning; whereas if it is an escape of coal-gas, the chances are largely in favor of his being rescued alive, and that his stupor will soon pass off on his removal to fresh air, and on the administration of restoratives.

It will not be possible to confuse the public on this score. Every one will appreciate the difference between a gas which destroys life before outside attention can, under ordinary circumstances, be attracted and help brought in time to save an unconscious sleeper; and one whose action is so slow that fatal results from its inhalation in bed-chambers are extremely rare.

Yours very truly,

CHARLES U. SHEPARD, JR.

LABORATORY FOR ANALYTICAL CHEMISTRY,
20 Broad Street (up stairs,)
CHARLESTON, S. C., September 17, 1880.

MAJOR H. E. YOUNG,

DEAR SIR :

I have been directed by Prof. Shepard, who is still absent from the city, to call your attention to the following points in connection with the article on water gas by Dr. Jones.

1. That the post mortem examination of victims from breathing coal gas shows effects precisely similar to those observed on bodies of animals poisoned by carbonic oxide.

2. That the symptoms are the same.

3. Consequently that authorities ascribe the poisonous effect of illuminating gas to the content of carbonic oxide, and judge of its danger in proportion to the amount of carbonic oxide present.

4. That the argument that carbonic oxide affords, on its combustion, less carbonic acid than light carburretted hydrogen, is apt to mislead in a comparison of the two illuminating gases. It is true that carbonic oxide is predominant in water gas, and light carburetted hydrogen in coal gas, but the former is so fortified with hydro-carbons (from the vapor of naphtha) that by actual experiment it gives fifty per cent. more carbonic acid, volume for volume.

Professor Shepard further directed me to state that you could find a refutation of the rest of Dr. Jones' article in his own first and last papers on the subject.

Very respectfully,

P. E. CHAZAL, *Ass't.*

APPENDIX E. PAPER 5.

AMERICAN GASLIGHT JOURNAL, October 2, 1880.

THE ILLUMINATING GAS OF NEW YORK CITY.

[By E. G. Love. Ph. D., Gas Examiner.]

A paper read at the meeting of the American Association for the Advancement of Science, Boston, August, 1880.

No city on the globe can offer so many different gas processes for study as New York and its immediate vicinity. With a genuine coal gas, a coal gas enriched with naphtha, a wood gas enriched with naphtha, a water gas made on the Tessie du Motay plan, a gas made by the Lowe process, another by the Strong process, and so on, one can study almost any phase of the gas industry.

There are ten companies in New York, and all, with but one exception, furnish illuminating gas to the city at the present time : New York, Manhattan, Mutual, Municipal, Metropolitan, Harlem, Central, Northern, Knickerbocker, and Yonkers. The Knickerbocker Works have recently passed into the hands of the Municipal Company and are undergoing alterations to adapt them to the manufacture of the water gas.

I shall limit myself to a description of the processes carried out by the companies on Manhattan Island.

The Manhattan Company is one of the oldest in the city, and has held its own in the manufacture of gas from coal, while other companies have yielded to the allurements of petroleum naphtha. The coals employed are from Pennsylvania and Virginia, with cannelton cannel as an enricher, which is considered far superior to English cannels. The average proportion in which these coals are used is eighty-seven per cent. of common coal and thirteen per cent of cannel, and in 1879 not far from 100,000 tons were carbonized. The distillation, conducted in the ordinary way, is carried to a yield of about 10,550 cubic feet per ton. The company at their two stations have 2,000 retorts, with a capacity of $6\frac{1}{2}$ million cubic feet in twenty-four hours.

One interesting feature of these works are the scrubbers used for removing the ammonia from the gas. They are the Livesey scrubbers, with some improvements by the company's engineer, Mr. C. V. Smith, and Mr. William Farmer. The scrubber (of which the company have four) consists of a cast iron tower, sixty feet seven and three-quarter inches high by sixteen feet ten inches diameter, built in eight vertical sections of sixteen segments each. "The inlet and outlet box is placed under the centre of each scrubber, upon a masonry foundation." A vertical pipe, twenty-four inches inside diameter and sixty-two feet four inches high, passes from this box to the top of the scrubber and is the outlet pipe for the gas.

The annular space around this pipe forms the inlet for the gas. The tower is filled with wooden trays made of quarter inch pine six inches wide, the trays being separated by strips of timber two by three inches. "The amount of wood surface in each scrubber is about 204,270 feet—say 4.7 acres."

It is customary to enclose these scrubbers in a building, but Mr. Smith constructed a wrought iron jacket, leaving a space between it and the scrubber of 20 inches at the base and 15 inches at the shaft. Near the base there are five circles of steampipes, which in winter heat the air and keep it above the freezing point.

The water distributer, which is the invention of Mr. Palmer, consists of an overshot water wheel 5 feet 10 inches in diameter, which by proper gearing turns a vertical shaft attached to the distributing arms. There are two of these arms extending from the centre to the outer edge of the trays. The water, which is pumped into a tank at the top of the tower, falls into the buckets of the wheel, which sets in motion the distributing arms. The water then passes into the arms, and serves to wash the gas. About 1.3 gallons of water are used to every 1,000 cubic feet of gas. These scrubbers are designed to pass two million feet of gas in twenty-four hours. The Company get $22\frac{1}{2}$ pounds of sulphate of ammonia for every ton of coal carbonized.

The purifying is done by lime entirely, one bushel purifying on an average 4,500 feet of gas. The spent lime is deodorized by drawing air through the purifying box by means of a steam jet exhaust, after which the lime is removed.

The Company have 18 gasholders, with a total capacity of five million cubic feet. The amount of gas made by the Manhattan Company in 1879 was 1,000 million feet. The specific gravity of the gas ranges from .437 to .500. The quantity of sulphur is about what is allowed in the gas of London, where the sulphur limit is enforced very rigidly. The average for 1879 was 20.92 grains per 100 cubic feet. The ammonia, however, is not correspondingly low, the average for 1879 being 5.91 grains in 100 cubic feet. The average illuminating power for the six months ending June 30, 1880, was 19.76 candles.

An analysis of this gas recently made will be found in tabular form at the end of this paper.

The Harlem Company divide the coal gas honors with the Manhattan. The coals used are the same as those used by the Manhattan Company, but the proportion of cannel is only about 10 per cent. In 1879 the Company carbonized 23,392 tons, with an average yield of 10,750 cubic feet per ton. The total make for the same year was 250 million feet.

In place of the condenser the Harlem Company employ the St. John and Rockwell scrubber with very good results. The principle of this apparatus is to wash the gas in its own liquors. It consists of four boxes, each box provided with a set of tubes whose lower extremities are submerged in the tarry matter taken from the hydraulic main. In this way the gas is made to bubble through the tar, and passing from one box to another, has its tar globules removed. It then passes through a series

of upright pipes, also a part of this apparatus, provided with a lattice work and corrugated plates, and emerges at a comparatively high temperature. The gas is cooled and still further purified by passing through two small water scrubbers, and then goes to the purifying boxes. Oxide of iron is the material employed, and one bushel will purify about 6,000 cubic feet.

Oxide of iron is not so efficient as lime in removing the sulphur compounds from gas, and we find the average amount for 1879 to be 47.56 grains per 100 cubic feet. At the same time the ammonia is lower, the average being 1.74 grains. The Harlem gas is not entirely free from sulphuretted hydrogen. The specific gravity of the gas is .435 to .480, and the average illuminating power for the first six months of 1880 was 17.59. The analysis of the Harlem gas will be found at the end of this paper.

The Metropolitan Company manufacture a gas half way between coal and water gas. The body of the gas is obtained from coal by distillation in the ordinary way, and this is afterward enriched by naphtha.

In 1879, 49,255 tons of coal were carbonized. The average yield for that year was 11,618 cubic feet of gas per ton of coal, the gas having an illuminating power of twelve to sixteen candles.

The coal retorts are of clay, heated by open fires or the Liegel regenerative furnace. This furnace is one of the best of its class, and is said to effect a saving of twenty-five per cent. in the amount of fuel.

The principle of a regenerative furnace is to supply only a limited amount of air to the fuel at first, the resulting non combustible carbonic acid, in passing through the incandescent fuel above, undergoes a decomposition, taking up another equivalent of carbon and forming combustible carbonic oxide. This carbonic oxide can be used in immediate proximity to the generating furnace, or carried to some distance, where it receives a secondary supply of heated air and is burned to carbonic acid. In the Liegel furnace the gases are burned immediately on their formation, and are not removed from the furnace as in the case of the Siemens. Hence the heating of the air becomes of less importance, as the gases do not need rekindling.

At the bottom there is a narrow slit for the admission of air and removal of the slag. From this point the furnace spreads very rapidly laterally, and also toward the back of the furnace. After reaching its maximum width at about a third of the distance up, it diminishes in width, terminating under an arch on

either side of which are the channels for the secondary air supply. Below the ground level the furnace projects somewhat, forming a well, into which the fuel is thrown through an opening in front.

A fire grate is constructed below the slit, with suitable air spaces to prevent the too rapid fusion of the slag, as in such a case the blocks of the main slit would be more exposed to the intense heat. By means of this grate the heat is such that the refuse from the fuel runs off as a thick slag, which is removed from time to time by a workman in the tunnel below the level of the retort-house floor. The secondary air supply is heated by passing through flues placed under the lower retorts. The Metropolitan Company are putting in 24 of these furnaces, with six retorts to a furnace. In 1879 the total amount of gas produced was 600,360,900 cubic feet.

The condensers to which the gas next passes are water condensers of the ordinary type. As the gas enters the scrubber it receives its enriching material, which is produced entirely independent of the coal gas. As has already been mentioned, petroleum naphtha is used, although by a little change in the retorts cannel coal can be employed if a high price of naphtha should render it more economical to use cannel.

The naphtha is converted into a gas in clay retorts similar to those used for the coal gas, but containing a large iron tube, which extends to the further end of the retort. Inside of this tube is a smaller one, extending half the length of the larger one, and into which the naphtha is fed from a tank, the supply being regulated by a stopcock. The object of these tubes within the retorts is to heat the naphtha vapor gradually. If projected into the retort direct great quantities of carbon would separate in the form of lampblack. By the time the naphtha vapor has passed through the iron tubes into the retort it has undergone partial decomposition into fixed gases. This decomposition is completed as the gas passes through the clay retort, although it must be said that often this decomposition is very imperfect, and naphtha vapor exists in the commercial gas.

The price of naphtha at present is from 2c. to 3c. per gallon. The Metropolitan Company use from 4 to 5 per cent. by weight, and calculate that one gallon will produce about 70 feet of 60 candle gas. There are no separate storage holders for the coal and naphtha gases, but one must be made in quantity to suit the other.

The coal and naphtha gases mix on entering the scrubber, and then pass to the purifying boxes. Dry lime is used, but

the lower trays of every second box are provided with sawdust moistened with sulphuric acid, to remove ammonia. One bushel of lime purifies 5,000 cubic feet of gas.

The foul lime is treated the same as that of the Manhattan Company, but the Metropolitan Company pay twenty-five dollars per scow load to have it removed.

From the purifiers the gas goes to the holders, of which the company have eight, with a storage capacity of 2,400,000 cubic feet.

The average illuminating power of the Metropolitan gas for the six months ending June 30, 1880, was 20.33 candles. The specific gravity varies from .538 to .651. In 1879 the sulphur averaged 19.76 grains, and the ammonia 3.67 grains per 100 cubic feet. At the end of this paper an analysis of the Metropolitan gas will be found.

The Mutual Company manufacture the body of their gas from wood, enriching with petroleum naphtha. This company previously manufactured a coal gas and enriched it with naphtha, but in September, 1879, they commenced making part of the gas from wood, still continuing the coal gas, however, to some extent. The results obtained proved so satisfactory that the proportion of wood gas has been increased, until now it is double that of the coal gas. I am informed that as soon as suitable arrangements can be made the coal gas will be discontinued altogether.

The French engineer Le Bon first proposed the use of wood for obtaining illuminating gas about the close of the last century. In countries where wood is abundant and coal is scarce this process is still employed to some extent, but it has generally been abandoned on account of the large percentage of carbon dioxide produced. The attempts to break up the wood tar into gaseous products by means of hot retorts have met with little success.

The Mutual Company make use of the charcoal to decompose the tar and convert the carbon dioxide to some extent into the monoxide.

The wood used is Virginia pine, for which the company pay $5.22, corded in their sheds. From September, 1879, to August 1, 1880, they distilled 2,125 cords, yielding 100,010,800 cubic feet of gas, or about 47,000 cubic feet per cord. In some cases, however, the yield reached 60,000 to 70,000 cubic feet. Each charge consists of eighty pounds, and as a cord weighs 3,300 pounds of 4 ft. 4 in. wood, there are about 41 charges in a cord.

The retorts are of clay, made in a peculiar shape, known as "boot" retorts. The total length is twenty feet; of this, 10 feet is at the charging end, with a diameter of 13 inches; then for 5 feet 2 inches the retort expands to a diameter of 24 inches, after which it has a diameter of 13 inches to the outlet end (4 feet 10 inches). The enlarged portion of the retort is produced by giving the lines of the retort a downward curve, the lower line at 10 feet from the charging end, and the upper at about 15 feet. Equally good results can be obtained with straight retorts.

The retorts are charged every two hours, and after each charge is distilled, the charcoal is pushed back into the boot, forming a solid mass of heated charcoal through which all the gas has to pass before reaching the stand pipe. In this way everything volatile is converted into gas. The charcoal is drawn twice in twenty-four hours.

The coal gas is made in the usual way, but the distillation is pushed to a yield of 15,000 cubic feet per ton of coal. This is mixed with wood gas and forms the body of the commercial gas. Its illuminating power is from 3 to 4 candles. The mixed gases are passed through a multitubular condenser, then through the scrubber filled with scrap tin, and lastly to the purifiers. Oxide of iron and lime are both used in purifying, the iron coming first.

The Mutual Company is the only one that reburns the spent lime. This is accomplished in ordinary lime kilns. The spent lime, after being deodorized to some extent, is made up into bricks 6 in. x 6 in. x 12 in. and burned, the operation lasting from 16 to 22 hours.

I am told the Company can reburn their lime and put it in the lime sheds for 2¾ cents per bushel, against 5½ cents paid for new lime.

The carburetter in which the gas receives its enriching material is a tank containing a number of inclined shelves, on which are placed coils of steam pipe. The naphtha, entering at the top, passes from one shelf to another, the steam pipes vaporizing it, while the gas enters from the bottom. The gas then passes to the fixing retorts. These are empty clay retorts 20 feet in length.

The gas is forced in at one end through a 2½-inch pipe, passes through the retort and out at the further end. It is then made to pass through charcoal for the purpose of arresting, so far as is possible, any naphtha vapor which escaped the fixing operation, after which it goes to the holders. Four and one-half gallons of naphtha are used per 1,000 cubic feet of gas. The Company have 11 gasholders, with a total capacity of 2½ million cubic feet.

The illuminating power for the first six months of this year averaged 26.53 candles. The specific gravity is greater than that of any other illuminating gas in the city, being .703 to .808. In 1879 the sulphur averaged 7.28 grains, and the ammonia 0.82 grains per 100 cubic feet.

The following analyses of the Mutual gas were made at different times. I. II. and III. are analyses of the gas made in part from wood; IV., an analysis made by Mr. Bowen in 1877, when the Mutual Company were manufacturing a poor coal gas and enriching with naphtha. These analyses show that the composition of the gas has not materially changed by the use of wood instead of coal.

	I. July 16, 1880.	II. Aug. 6, 1880.	III. Sept. 8, 1880.	IV. Nov. 27, 1877.
Hydrogen	9.65	9.32	12.75	7.53
Marsh Gas	43.55	42 49	39.21	48 63
Carbonic oxide	8 63	7 64	12.33	6.70
Illuminants	15.55	15.45	15.22	14 43
Nitrogen	19.92	22.79	19.36	19.85
Carbonic acid	1.48	2.16	0.89	
Oxygen	1.22	0.15	0.24	2.86
Sulphuretted Hydrogen	....	....	Trace.	
	100.00	100.00	100.00	100.00

The Municipal and New York Companies are manufacturing what is known as water gas. That is, steam is decomposed by means of incandescent carbon, with the formation of hydrogen, carbonic oxide, and some carbonic acid. This is enriched by petroleum naphtha. A description of the process as carried on by the Municipal Company will answer for both. It should be said that previous to May, 1880, the New York Company were engaged in the manufacture of coal gas. but becoming convinced that water gas was evidently destined to be the gas of the future, they purchased of the Municipal Company the right to manufacture according to their process. The process employed by these companies is that of Tessie du Motay, and a few words as to its history may be of interest. The enterprise started in an attempt to manufacture oxygen gas from the manganates or permanganates of soda or potash, in connection with what was known as the Tessie du Motay carburetted water gas. The patents passed into the hands of a Mr. Stern, and a company was formed to work these patents. Two sets of pipes were laid, one for oxygen and the other for the water gas, the object being to furnish the lime light for street illumination. The undertaking,

however, proved a failure, and the oxygen part of the light was abandoned. The plant necessary for the production of the water gas was very imperfect, and promised very little in the way of manufacturing a merchantable gas. Mr. Stern, however, succeeded in interesting some New York capitalists in the scheme, and works were erected for the purpose of giving the water gas a trial. The result of the undertaking was the formation of the Municipal Gaslight Company, to whom Mr. Stern sold all his interest in the Tessie du Motay process, so far as New York city was concerned. The process starts with the gasogens or generators for producing the water gas. They consist of two connected furnaces, placed in a vertical position, and made of iron with a fire-brick lining. Between these furnaces there is a fire-brick partition, which contains the pipes for superheating the steam. At the upper end of this partition is the flue which connects the two furnaces, permitting the gases to pass off by a common stand pipe. Below the fire grates are the pipes for the air supply when the blast is on. The steam enters the furnace at a point above the air blast and where the heat is the most intense. The carbon used is anthracite coal, with which the gasogens are filled; and when charged each gasogen holds aboot ten tons. The charging is done every hour, when from 700 to 1,000 pounds of coal are added. In working, the air blast is turned on and the cap at the upper extremity of the stand pipe (which serves as a chimney) is opened. When the heat becomes sufficient for decomposing steam the air blast is turned off and the steam turned on, the upper end of the stand pipe being closed at the same time. This continues for about ten minutes, when the temperature becomes so low that the decomposition of the steam is imperfect. The air blast is then turned on for ten minutes. The two are thus alternated until the fire needs raking, when the ash pit doors, which were previously closed and luted, are opened. The gas from the gasogens passes into an iron box filled to a certain point with water which acts as a seal when the air blast is on; it then passes to the holder. The Municipal Company have twelve of these gasogens arranged in pairs. One ton of anthracite yields 45,000 feet of gas together with a considerable amount of half-burned coal, which is used under the steam boilers. Deducting this half-burned coal, the yield per ton is from 55,000 to 60,000 cubic feet. The gas next passes to the carburetters to receive the enriching material. The carburetters, of which the company

have four, consist of a series of iron pans, ten in number, placed one above another. These pans are connected by pipes which serve to convey the gas from one pan to another, and also as overflows for the naphtha. The naphtha enters at the top, fills the first pan to a depth of several inches and overflows into the next by the connecting pipes, and so on until all the pans are filled. In practice, however, only the top pans contain naphtha, as this furnishes sufficient enriching material for the illuminating power desired. The gas enters at the bottom and passes over the surface of the naphtha, taking up the vapor. A most important feature of the carburetters is the hot water jacket which surrounds them and serves to vaporize the naphtha. The water is heated by steam pipes to about 175° F., which is the temperature necessary to form the vapor for the illuminating power desired. The company use five gallons of naphtha per 1,000 cubic feet of gas. The next step in the process is the "fixing" of the naphtha, which is very important, from the fact that a slight lowering of the temperature would result in condensing the vapor which is to give the illuminating power. The fixing is accomplished in through retorts from 17 to 18 feet in length; and it takes 12 of them to "fix" the gas from one generator. The gas enters at one end through pipes provided with valves to regulate the quantity, passes the length of the retort and out by the stand pipe at the other end. The retorts contain five movable partitions of fire-brick, $2\frac{1}{2}$ inches thick, with holes in them for the purpose of breaking up the current of gas and arresting any lampblack which may be formed. The greatest care is necessary to maintain the proper heat. If the retorts become too hot the naphtha is largely removed in the form of lampblack, while if the heat is not high enough the naphtha vapor passes over with the gas. The Company have a very ingenious test for determining the heat of the retorts, which I believe is covered by a patent by Mr. H. C. Bowen. It consists of a small jet of gas taken from the stand pipe of each retort just before it enters the hydraulic main. The jet of gas is allowed to impinge upon a slip of paper. If the heat is very great a black mark will be made on the paper, and the foreman turns more gas into the retort to reduce its temperature; on the other hand, if the heat is very low no mark whatever is made on the paper, and the supply of gas for that particular retort is reduced. A dark brown tint is aimed at. From the hydraulic main the gas passes to the multitubular condensers, then to the scrubbers filled with scrap

tin, and lastly to the lime purifiers, the same as with coal gas. The Municipal Company have two holders for crude water gas with a capacity of 250,000 feet. They are constructing a holder for the illuminating gas, to hold two million cubic feet. This, with the holders now in use, will give them five for the illuminating gas, with a storage capacity of 3½ million feet. An interesting point in this connection is the fact that in the process of "fixing," some members of the marsh gas series are converted into the aromatic series, as is shown by the deposits of naphthaline. I have here a naphthaline candle made by dipping this stick into the inlet drip of one of the holders, lifting it out until the naphthaline had hardened, and repeating the operation. The commercial gas of the Municipal and New York Companies contain about five grains of sulphur per 100 cubic feet, and is free from ammonia as a rule. The specific gravity varies from .637 to .664. The average illuminating power of the Municipal gas for the first six months of the present year was 29.68 candles. The average illuminating power of the New York gas for the months of May and June last was 24.35 candles.

In the following tables I have arranged some information gathered from various sources. The analyses of the different gases will be found in Table No. 1. Table No. 2 relates to the public lighting, and is abstracted from the reports of the Superintendent of Lamps and Gas. No. 3 contains a few facts concerning the different companies, and for these facts I am largely indebted to the courtesy of the officers of the companies.

TABLE No. 1.

Constituents.	Mahat-tan Co.	Harlem Co.	Metro-politan Co.	N. Y. Mutual Co.	New York Co.	Municí-pal Co.
Hydrogen...............	45 79	46.53	35.41	10.57	27 14	26 25
Marsh gas..............	39.01	42.38	42.66	41.75	25.35	28.91
Carbonic oxide..........	6.31	3.14	9.17	9.53	26.84	27.12
Illuminants.............	6.38	6.31	7.41	15.41	14.63	15.80
Nitrogen................	2.51	0.50	5.35	20.69	2.87	1.92
Carbonic acid...........	.....	1.08	....	1.51	3.02	.....
Oxygen...	....	0.06	.....	0.54	0.15	.....
Sulphuretted Hydrogen..	.....	trace	.....	trace	.....	.....
	100.00	100.00	100.00	100.00	100.00	100.00

These analyses were made from time to time as opportunity presented. In some cases I have given the average of several analyses, in the hope of thus arriving at a fair estimation of the constituents present in the gases of the different companies. The method of analyses followed was that of Professor Bunsen.

With information as to the nature of the gas, gathered from daily photometric tests, I have had opportunity of analyzing these gases at times when they presented some unusual features. I find considerable variation in composition, especially in those gases enriched by naphtha. The analyses given, however, I believe to fairly represent each gas. I regret that the time at my disposal was so limited as to prevent my separating the light giving portion or illuminants of the different gases. This would have been especially interesting in the water gas of the New York and Municipal Companies.

TABLE No. 2.

Gas Company.	Number of Public Lamps, June 30, 1880.	Price per Lamp, 1880.	Quantity of Gas used in Public Buildings in 1879. Cubic Feet.	Price Charged for Public Buildings. 1000 cubic ft. 1879.	1880.
Manhattan..............	6,807	$15 00	3,696,000	$1 90	$0 75
Harlem..................	4,694	17 00	332,800	2 00	1 25
Metropolitan............	4,292	15 00	239,860	1 50	60
New York Mutual	1,045	15 00	13,800	1 50	2 25
New York...............	3,557	15 00	6,727,100	1 90	1 40
Municipal..............	......	19 00	2,728,300	1 90	2 25
Yonkers................	73	30 00	....	....	....
Central.................	1,836	45 00* / 35 00†	....	....	....
Northern	1,090	50 00* / 42 50†		....	....
Total..............	23,394	‡	13,737,860 §	....	....

* Old lamps. † New lamps.
‡ The cost of lighting the public lamps in 1879 was $420,677.73.
§ The cost of lighting the public buildings in 1879 was $26,122.45.

TABLE No. 3.

Gas Company.	Coal Carbonized in 1879. Tons.	Gas Made in 1879. Thousands.	Gallons of Tar. 1879.*	Gallons of Ammoniacal Liquor. 1879.*	Revenue from Tar. 1879.	Revenue from Ammoniacal Liquor. 1879.	Meters in Use. August, 1880.	Miles of Mains.	Number of Holders.	Storage Capacity of Holders. Thousands.
Manhattan	100,000	1,000,000	1,200,000	1,500,000	$10,000	$10,000	30,000	173	18	5,000
Harlem	23,392	250,000	280,704	350,880	7,017	2,339	6,000	118	3	990
Metropolitan	49,255	600,360	591,060	738,825	9,851	4,925	19,000	130	8	2,400
New York Mutual	26,345	695,000	316,140	395,175	5.269	3,951	17,287	118	11	2,500
New York	55,826	564,854	669,912	837,390	5,582	5,582	14,561	110	5	3,500
Municipal	......	550,000	......	......	......	......	6,000	95	5	3,500
Knickerbocker	......	......	......	......	......	......	......	130†	..	.....
Total	654,818	3,660,214	3,057,816	3,622,270	$37,719	$26,797	92,848	874	50	17,890

* These figures are necessarily only approximate. They are calculated on 12 gallons of tar and 15 gallons of ammoniacal liquor per ton of coal.

† Including the Yonkers, Central and Northern Companies.

APPENDIX E. PAPER 6.

[AMERICAN PROGRESS, MARCH 24, 1883.]

POISONOUS ILLUMINATING GAS.

The death of a guest at the Putnam House a few days since by the inhalation of illuminating gas adds another to a long and rapidly increasing list of victims of water gas. Nearly one hundred persons have been fatally poisoned in this city by this gas since its first introduction in 1878, and when we heard of the death mentioned above we had no doubt as to its cause, but thought it best to verify our theory before making a statement. We found that the gas was furnished by the Municipal Company, which uses the Tessie de Motay process in the manufacture.

In view of the appalling array of fatalities traceable to this cause, we believe our readers will be interested in a statement of facts bearing upon the subject.

Water gas is manufactured by passing steam through a mass of incandescent coke, or other material, a process which changes the vapor into gas, and at the same time abstracts its oxygen by chemical affinity, passing over the combustible hydrogen to the receiver. Another combustible product of the process, upon which the profit of the manufacturer largely depends, is carbonic oxide, which is one of the most rapid and deadly poisons, and the cause of nearly, if not quite, all the fatal accidents that have occurred.

An attempt was made to introduce the water gas in France, where it originated. Many experiments were made and much money expended, but several accidents having occurred, a scientific examination was made, and its use was forbidden on account of its poisonous properties. The business promised to be profitable, but it was abandoned in that country, "because the gas was so fatally poisonous that the public authorities prohibited its use."

M. Pelouze, in his report to the Municipal Council of Paris, says:

"It was proven that a mixture of one per cent of oxide of carbon killed a strong dog in a minute and a half. It was a case of poisoning. With one per cent of oxide of carbon all animals died at the end of a few minutes. These experiments terrified me. Since then they have been repeated many times by men of science. Carbonic acid must not be confounded with oxide of carbon. In the course of the experiments of

which I have just spoken, I formed an artificial atmosphere with thirty per cent of carbonic acid. A large dog, on being placed in it, almost immediately fell on his side, but recovered himself on being restored to the pure air. Thirty per cent of carbonic acid did not kill; but, on the contrary, one per cent of oxide of carbon is mortal."

To show the danger of the water gas as made and delivered in this city, we subjoin an analysis of the gas of the Municipal Gaslight Company, made by Prof. Henry Wurtz, Ph. D., together with an analysis of genuine coal gas by the same authority:

COAL GAS.		WATER GAS.	
Hydrogen	42.47	Hydrogen	38.20
Carbonic Oxide	2.08	Carbonic Oxide	27.14
Marsh Gas	46.16	Marsh Gas	15.82
Illuminants	6.67	Illuminants	15.29
Air	2.62	Nitrogen and Oxygen	3.45
		Carbonic Acid	.10
	100.00		100.00

It is seen by the above that water gas contains over thirteen times as much carbonic oxide (a rank poison) as coal gas, and must be at least thirteen times more dangerous to use. Experience, however, seems to warrant the assertion that the proportion is in practice at least 160 to 1.

In other words, water gas is at least 160 times more dangerous to distribute than coal gas, or a gas containing from two to six per cent of carbonic oxide.

NOTE. In order to ascertain whether the opinion here given was by authority and if it expressed the present views of Prof. Morton, I communicated with him and received the reply which is appended to a copy of the "American Gaslight Journal" of March 16, 1878, herewith forwarded. J. H. R.

An exhaustive opinion upon this subject has been prepared by Prof. Henry Morton, President of the Stevens Institute of Technology, in which he takes the ground that water gas, from its large per cent. of carbonic oxide, is extremely dangerous when distributed for illuminating purposes, and quotes largely from recognized authorities, several of which we reprint:

"Thompson's Chemistry," London, 1831, vol. 1, p. 168, under "Carbonic Oxide:" "No animal can breathe it; when the attempt is made, one or two inhalations occasion asphyxia."

Chenot (article in the "Comptes Rendus" of the French Academy, 1854, p. 735), on pure carbonic oxide considered as a poison: "The pure carbonic oxide is not simply a reducing agent of the greatest energy, but a frightful poison (un poison

foudryant)" in any small doses. "Finally, it appears that poisoning by carbonic oxide is the most terrible in itself, and brings after it profound disorganization."

Bernard: "Le cous sur les effets des substances toxiques" (Paris, 1856), this author says: "Carbonic oxide is one of the most poisonous gases known."

"Elliott & Storer's Chemistry," New York, 1871, p. 338, under "Carbonic Oxide:" "It extinguishes combustion just as hydrogen does, and destroys animal life. Unlike hydrogen and nitrogen, however, it is a true poison. It destroys life, not negatively by mere suffocation or exclusion of oxygen, but by direct noxious action. Even when largely diluted with air it is still poisonous, producing giddiness, insensibility, and finally death. Much of the ill repute which attaches to carbonic acid really belongs to carbonic oxide, for since both these gases are produced by burning charcoal, many persons are liable to confound them; but carbonic acid is, comparatively speaking, almost innocuous. Carbonic acid, it is true, is somewhat poisonous; it does not suffocate like water or nitrogen or hydrogen, but it is very much less poisonous than carbonic oxide. It has been found by experiment that an atmosphere containing only one hundredth of carbonic oxide is as fatal to a bird as one containing one twenty-fifth part of carbonic acid."

The opinion concludes with the following:

"The large quantity of carbonic oxide in water gas (often 34 per cent.) would render its employment dangerous as an agent of illumination."

In the same connection we give an extract from report of Gas Commissioners of the city of Boston, 1876:

"The second objection has much greater weight, and is, in our opinion, sufficient to entirely prevent the use of the mixed hydrogen and carbonic oxide alone for heating purposes, for the reason that, since it is devoid of odor, its escape from pipes and diffusion through the air of an inhabited room in dangerous amount could not be detected.

"In reference to the poisonous nature of this gas, the constituent carbonic oxide is one of the most active poisons, producing, when inhaled, speedy death. It does not act like carbonic anhydride, which, when it poisons, does so by merely preventing the entrance of air or oxygen into the lungs, as is the action of water in drowning, and persons can be as readily resuscitated after confinement in an atmosphere of pure carbonic anhydride as after

confinement under water. Moreover, accidents from this gas can readily be prevented by a moderate dilution with atmospheric air. Carbonic oxide, on the other hand, is a true physiological poison, producing death almost as readily when diluted as when pure. It forms a compound with the red coloring matter of the blood, which is much more stable than that formed by carbonic anhydride, and cannot be readily decomposed by oxygen. 'Carbonic oxide is a gas of so poisonous a character that, according to Leblanc, one volume of it diffused through one hundred volumes of air totally unfits it to sustain life; and it appears that the lamentable accidents which too frequently occur from burning charcoal or coke in brasiers or chafing dishes in close rooms, result from the poisonous effects of the small quantity of carbonic oxide which is produced and escapes combustion; since the amount of carbonic anhydride thus diffused through the air is not sufficient in many cases to account for the fatal result.'

"When it was proposed to supply the Hôpital des Invalides in Paris with water gas, a commission was appointed, consisting of Messrs. Dumas, Chevreul and Regnault, eminent chemists, to investigate it. They found that it contained from thirty-four to forty per cent. of carbonic oxide, and reported 'that it would be dangerous to the occupants of the institution to introduce, even by way of experiment, gas obtained from the decomposition of water according to the Kirkham process.'"

The slightly poisonous properties of coal gas are caused by the small per cent. of carbonic oxide, since the more abundant constituents (hydrogen and marsh gases) are simply irrespirable, *i. e.*, non-life-sustaining, but are not poisonous, and the authorities seem agreed in estimating the deleterious effects of coal gas by its percentage of carbonic oxide. But as water gas contains, according to the analysis given, thirteen times as much carbonic oxide as coal gas, it is not strange that numerous deaths have resulted from the substitution of the former for the latter, or that the use of an illuminating gas possessed of such deadly properties has been expressly forbidden in countries where the preservation of the citizens' life is a matter of serious governmental concern.

The unignited escape of water gas for a few hours from an open burner of the ordinary size, into a close sleeping apartment of common dimensions, would introduce sufficient carbonic oxide to jeopard, if not destroy, human life, since (as before quoted) the contents of this poisonous gas has only to reach 1 per cent. to prove deadly to an unconscious sleeper.

Again, the products of the combustion of water gas are more deleterious than those of coal gas. When equal volumes of both are burnt, water gas produces about fifty per centum more carbonic acid gas. Consequently with the same consumption of water gas and coal gas, the atmosphere of an apartment would be much sooner vitiated by the use of water gas.

Perhaps the most terrible calamities arising from the inhalation of illuminating gas occur in houses into which the service pipes have not been introduced, but into which the gas finds its way through drains or other openings from a defective main, and where the true cause of the trouble is at first passed over owing to the non-consumption of gas on the premises. That under such circumstances the consequences would be much more serious with water gas than with coal gas, follows very naturally from my previous remarks on carbonic oxide. In fact, widespread disorders which were at first regarded as epidemics of cerebro-spinal meningitis and typhoid fever have been traced to the presence of carbonic oxide in the atmosphere.

Chas. U. Shepperd, Jr., analytical chemist, says:

"We often read and hear of such accidents with gas, but they are seldom fatal, and the victims of such accidents, by removal to pure atmosphere, soon recover. But I am very much of the opinion, should the leak occur with water gas, that the victim when found would be past human aid; instead of the physician, there would be a call for the coroner. Another fact which makes water gas more dangerous than coal gas is that it is about double the specific gravity of coal gas, also heavier than the air, and consequently will not diffuse itself rapidly, but settle to the lower portions of the room and render the atmosphere there quickly dangerous to the occupants. Coal gas, on the other hand, is lighter than atmospheric air; it ascends and only slowly diffuses itself down towards the lower parts of the room, where its more intense and easily recognized odor will soon give notice to the occupants that something is wrong, and insure an investigation to find out and remedy the defect."

Chas. M. Cusson, M. D., says:

"Asphyxia by carbonic acid, hydrogen, or olefiant gas, is not poisonous. The action of carbonic oxide upon the human system is of a different nature from that produced by any of the gases enumerated. In addition to asphyxia, carbonic oxide produces

an organic change in the blood, a poisonous change, which, when once established, places the patient beyond the reach of antidotes."

The following ghastly record of fatal and serious accidents resulting from the inhalation of illuminating water gas in New York city and the city of Brooklyn, from 1878 to 1882, tells its own story:

(For list of names, see page 93.)

Although somewhat in the nature of a digression, we can hardly forbear saying that the methods by which the new gas has been forced upon the people are hardly less objectionable than the character of the gas itself. In Brooklyn, for instance, the people of several districts have unwittingly become users of the poisonous gas in consequence of the absorption of a number of the smaller companies who formerly furnished coal gas, by the Standard Oil Company, which is known as a grasping and merciless petroleum monopoly, and whose object in this instance is to furnish an outlet for their naphtha. The monopolists said, in effect, to the small and struggling company: "Buy your gas of us, or we will ruin you." It was a question of being squeezed or wiped out entirely, and there were problems involved which would hardly admit of the latter solution, as the stock was largely held by widows and orphans whose interests could not be sacrificed rashly. So the villainy was consummated, and the price of gas was at once advanced fifty cents per 1,000 feet—the extra price going into the pockets of the new partners. Other companies were forced to sell forty per cent. of their stock to the Standard Oil Company at fifty cents on the dollar by a threat to lay pipes through the best streets, selling at a low price, leaving the old company to supply the balance of the district at a ruinous disadvantage.

The Brooklyn and Nassau Gaslight companies still sell their gas at two dollars per 1,000 feet, while the customers of the other companies are compelled to pay two dollars and fifty cents for no advantage, unless the privilege of increasing the death rate might be regarded as such.

Since putting the above in type, two cases, precisely in point, were given in the same edition of the "Brooklyn Eagle."

Two domestics of Mrs. Togetti, of No. 230 Livingston street, slept together in a small room, in which gas was escaping from

10 P. M. till 7 A. M., at which hour the door was opened and they were found unconscious. The windows were opened, fresh air admitted, and at 11 A. M. they were pronounced out of danger.

On the same evening Mrs. Hannah C. Johnson, of No. 215 Graham street, met with a precisely similar accident, and at 7 A. M. she was dead, and could not be resuscitated.

The first case was in the district of the Brooklyn Gaslight Company, who serve coal gas. The second was in the People's district, who had been serving water gas since the 1st of March. The company had sold coal gas for fifteen years without a fatal accident, but during the first fifteen days of water gas a death occurred.

In view of these facts, we would suggest that our readers would do well to hesitate before introducing the new gas into their premises, and that an examination of the gas and its consequences to the public safety, by the Health Department, would be in order.

APPENDIX E. PAPER 7.

STATE OF NEW YORK, COUNTY OF KINGS, SS.:

John B. Chichester being duly sworn deposes and states as follows: I reside at No. 51 Nevins street, in the city of Brooklyn, and am a practical engineer, and for upwards of twenty-five years have made gas engineering a specialty. I have constructed works for the manufacture of illuminating gas from coal and from other products as used for that purpose. I am familiar with the usual method of manufacturing gas from coal, and also the method of manufacturing what is commonly called water gas, and as manufactured in the cities of New York and Brooklyn. I have had charge of works for the manufacture of coal gas and water gas, and know the effect of inhaling both of such gases, on men and animals. I have seen a great many persons prostrated by inhaling such gases. The effect of water gas upon them, according to my observation, is certainly no worse than that of coal gas, in fact they recover sooner.

I have been prostrated both by inhaling coal gas and water gas. I know that the effects of inhaling coal gas have been, upon me, more serious than from inhaling water gas; the prostration from inhaling coal gas is greater and lasts longer, when inhaled by me, than from water gas.

The process of manufacturing water gas is much more cleanly than coal gas, and the men generally employed in manufacturing water gas in the cities of New York and Brooklyn are, in my judgment, quite as healthy as those manufacturing coal gas or any other similar work.

J. B. CHICHESTER.

Sworn before me this twenty-fourth day of April, 1883.

D. L. BUCKMAN,

Notary Public, Kings County.

APPENDIX E. PAPER 8.

COUNTY OF KINGS, CITY OF BROOKLYN, SS.:

Henry P. Morgan being duly sworn says, that he resides in the city of Brooklyn and is President of the Nassau Gaslight Company, that he has been president of said company since November, 1870; that during said period the said company has manufactured coal gas, has laid upward of twenty-five miles of street mains, several thousand services connecting with street mains, and erected nearly one thousand lamp posts connecting with street mains; that the men employed in making each of the said connections necessarily inhaled the gas manufactured by said company; that this deponent has never heard of any accident to the men so employed from inhaling said gas, nor of any death, illness or other ill effect resulting from such inhalation; that he has never heard of any accident to, or of the death or illness of, or other ill effect upon any person residing, doing business or employed in any dwelling houses, stores or other buildings supplied with the gas manufactured or served by the said company, arising from inhaling the said gas; that no case when illuminating gas, as manufactured and served by said company, is charged with having produced death or illness has come to the knowledge of this deponent; that this deponent, from his position as president of said company, would have known of any death, accident, illness or other ill effects arising from the use of said gas.

Deponent further says that he caused a determination of the amount of carbonic oxide contained in gas manufactured from coal to be made by Professor A. K. Eaton, chemist ,of this city.

That the determination showed that the said gas contained 4.25 per cent. of carbonic oxide; that he caused a similar determination to be made by the said Professor Eaton of the amount o carbonic oxide in water and naphtha gas; that the said determination showed that the last mentioned gas contained 24.75 per cent. of carbonic oxide.

HENRY P. MORGAN.

Sworn before me this twentieth day of April, 1883.

T. MAYNARD,

Commissioner of Deeds.

APPENDIX E. PAPER 9.

WATER GAS IS NOT MORE DANGEROUS THAN COAL GAS.

STATEMENTS OF THE MOST EMINENT CHEMICAL AUTHORITIES IN THE WORLD.

Report of Professor C. F. CHANDLER, President of the Board of Health, to the Board of Aldermen, city of New York.

The President laid before the Board the following communication from the Board of Health:

HEALTH DEPARTMENT,
NEW YORK, April 15, 1881.

To the Honorable the Board of Aldermen:

At a meeting of the Board of Health, held on the 13th inst., the following report of the President was unanimously adopted, and a copy was ordered to be forwarded to your Honorable Body:

REPORT:

I have the honor to report that the petition of citizens referred to the Board of Health by the Honorable the Board of Aldermen, with regard to the illuminating gas which is manufactured from steam, anthracite coal and naphtha, the so-called water gas, has been duly considered.

This gas has been extensively used in the city of New York for some years, in public and private buildings. While it differs

somewhat in composition from the gas manufactured from bituminous coal, it involves in its careless use the same sources of danger ; if allowed to escape into the air without being burned it produces an explosive mixture with the air, and it is also liable to suffocate persons who may remain for any length of time in the atmosphere thus contaminated. There are no facts which give any substantial foundation for the apprehensions of the petitioners that this gas is in any way more dangerous than the gas previously in use. I would further state that the allegation that this water gas has been prohibited in Paris is directly denied by Professor Adolphe Wurtz, of that city, in a letter which I have before me ; that the greater density of the gas causes it to escape more slowly from leaks than does ordinary coal gas, and that its odor is so decided that leaks are detected just as readily as in the case of other gas. In conclusion, I would say I see no reason why any official action should be taken on this subject.

C. F. CHANDLER,

(A true copy.) *President.*

——— ———, *Secretary.*

Which was referred to the Committee on Police and Health Department.

ROYAL COLLEGE OF CHEMISTRY,
SOUTH KENSINGTON MUSEUM,
LONDON, May 16, 1878.

SIR: In compliance with your request I have read the reports of Dr. Henry Wurtz, dated January 1, 1878, and March 4, 1878, on the composition and properties of the gas of the Municipal Gaslight Company, of New York, and also the articles published by Prof. Henry Morton, in the "American Gaslight Journal" of March 2 and 16, 1878, and having been called upon to express the adaptability of water gas for lighting and heating purposes, I have no hesitation in saying that it may be used with safety, both in public buildings and private houses. I should be delighted to substitute this pure and powerful illuminating agent for the gas with which my house in London is at present supplied, although it is used in all the bedrooms.

[Signed.] E. FRANKLAND,

TO CHARLES G. FRANCKLYN, Esq.,

Pres. Municipal Gaslight Company of New York.

[From Adolphe Wurtz, member of the Institute, Professor at the School of Medicine and the School of Sciences, Paris, France.]

PARIS, June 12, 1878.

SIR: I have read with attention and interest the documents concerning the gas of the Municipal Gaslight Company, of New York, which you have forwarded to me.

I have acquainted myself with the extensive and exact work which Dr. Henry Wurtz has published about the composition and use of the gas produced by the decomposition of steam on the incandescent carbon, and saturated with very volatile hydrocarbons obtained from petroleum, the gas possesses an intense illuminating power, a marked smell and a sufficient density. I have been struck with the correctness of the remarks which terminate the report of Dr. H. Wurtz, and which, in my opinion, answered the objections formulated by Dr. Henry Morton, inserted in two articles in the "American Gaslight Journal," published in New York. No doubt the danger of poisoning exists with all gas containing carbonic oxide, and coal gas is not exempt from the latter, as it can contain as much as twelve per cent. of its volume. But I think the danger, which could only have sad consequences in exceptional cases, and through a sort of fatality, has been exaggerated, and should not be taken into account, considering that gas is used without hesitation for lighting our houses, notwithstanding the very real danger of explosion and fire, no matter what kind of gas or its composition.

Further, the use of water gas has never been prohibited in France, and if the numerous processes which have been indicated for its production have been abandoned or have received only a restricted application, the cause is principally due to the circumstance that the technical and economical conditions of the production have, up to the present time, been very unfavorable.

In manufacturing under good conditions, a gas remarkable on account of its illuminating power and of a sufficient smell to reveal its presence, you have realized an important progress. It would appear to me unjust to deprive you of your useful discovery.

[Signed] ADOLPHE WURTZ,

Member of the Institute, Professor at the School of Medicine and the School of Sciences.

To CHARLES G. FRANCKLYN, Esq.,

President, Municipal Gaslight Company of New York.

The general question as to whether water gas is a safe and desirable illuminant was referred by the Mayor of New Orleans to Dr. Joseph Jones, President of the Board of Health, with the following reply:

NEW ORLEANS, August 9, 1880.

HON. I. W. PATTON, *Mayor of the city of New Orleans:*

SIR:

In reply to the communication of your honor, of the 6th ult., propounding certain inquiries with reference to the chemical composition, poisonous properties, and relative value of water gas, I respectfully submit the following outline of the results of my investigation:

* * * * * * *

1. Its pure brilliancy and illuminating power far surpasses the ordinary coal gas flame, and equals the renowned B and cannel coal gases of Scotland.

2. Respecting the purity of the gas, it is composed of fixed gases like air, unchangeable by heat and cold, and almost absolutely free from gummy vapors which are constantly such a great detriment in the old process.

3. As regards the effects of its use on health, those who have used the gas most extensively testify to the fact that it is in no manner dangerous, and is as safe in this respect as ordinary coal gas.

4. The products or effects of burning the water gas are less objectionable than with gas from gas coal. An illuminating gas with a basis of water gas yields in burning less water and carbonic acid, and consumes less oxygen of the air for equal volumes than any average gas of less candle power made from pure gas coal.

From the preceding facts we conclude:

1. Water gas is superior to the ordinary coal gas in heating and illuminating power.

2. Water gas can be furnished at less cost to the consumer than ordinary gas.

3. Water gas is not more dangerous in case of leakage than that made from gas coal.

4. The products or effects of burning water gas are less objectionable and less injurious than those arising from the combustion of coal gas.

Respectfully,

[Signed] JOSEPH JONES, M. D.,

President Board of Health, State of Louisiana.

[Dr. R. Ogden Doremus, Professor of Chemistry and Toxicology, Bellevue Hospital Medical College, New York.]

"Having been informed that parties are circulating reports that water gas is particularly poisonous, and having been requested to express an opinion on this subject, I beg leave to state that the trivial variations in the gases made by different processes is of no importance in regard to health, excepting as to the products of their combustion. In this respect water gas is superior to all others, as it does not contain impurities existing in gas manufactured from bituminous coal."

Regarding the comparative safety of coal gas and water gas, Prof. T. Sterry Hunt of Montreal, writes:

"I must say, however, that the notion of any important difference in the safety or fitness for use of two such gases seems to me to be absurd. The only questions to be raised are the relative cheapness and illuminating power."

Dr. Gideon E. Moore of New York, the eminent analytical chemist, says:

'I consider carbonic oxide to be a highly desirable ingredient in water gas; its density and high flame temperature greatly promotes the illuminating effect and retards waste."

The eminent chemist, Prof. Henry Wurtz, Ph. D. of Hoboken, N. J., says:

"No accumulation of citations of vague and crude opinions, stereotyped through generations of school books, as to the danger of small percentages of carbonic oxide in air should have any influence on reasonable minds, when it is only by rare accident or stupidity that even these small percentages can be communicated to the air of a close room. I am confirmed in my conclusions, that whatever dangers to life and health may or do arise from the use (or rather abuse) of illuminating gases, these will not be enhanced in any way by an increase in its proportion of carbonic oxide.

"Stoves and furnaces through accident or defect often emit carbonic oxide into our dwellings to a far greater extent than could proceed from any leak in gas pipes. Yet stoves and furnaces are not practically condemned for this."

[CONCLUSIONS.]

"I would sum up my two months' incessant and laborious study of the chemistry of your gas, as follows;

1. The Municipal Gaslight Company is serving out to consumers a gas of uniform quality, which compares in brilliancy, whiteness, and other qualities of light, with the finest cannel gas; while destitute of any fuliginous or smoky properties, as well as of any liability to condense by ordinary cold; its illuminating power for five feet per hour, measured by one of the test meters of the American Meter Company, being uniformly up to twenty-four candles, during my experiments.

2. This gas, in the case of equal leakage, will not be more dangerous to health than gas from gas coal; and by reason of its higher density and less liability, therefore, to leakage under equal pressure, it will, I believe, be less dangerous this way than gas from coal.

3. By reason of the greater density of this gas, its diffusive tendency through air is less, and it will hence be slower than coal gas in forming explosive mixtures with air, even in case of equal leakage.

4. On account of its far smaller proportion of marsh gas, the violence of the explosions of equal volumes with air will be much less; and the introduction of your gas will therefore reduce risks both to life and property.

Respectfully,

HENRY WURTZ.

HOBOKEN, March 4, 1878.

[From Dr. E. G. Love, Analytical Chemist and Official Gas Examiner of New York City.]

NEW YORK, Jan. 31, 1883.

I will say that I think the only questions relative to water gas that need be considered by any gas company, are the economy of production and equality of the light. I do not consider the presence of carbonic oxide in illuminating gas as objectionable.

I might add that in 1879 the Municipal Company of this city made 550,000,000 cubic feet of the so-called water gas, and in May, 1880, the New York Company adopted the same process, and I have no doubt that the present yearly consumption of water gas in this city is over one billion cubic feet.

[Signed] E. G. LOVE, *Ph D.*

[Prof Henry Morton, Ph. D., President Stevens Institute of Technology, Hoboken, N. J.]

In a letter to the "Plumber and Sanitary Engineer," of New York, January 15, 1880, says:

I am quite ready to admit that when the subject first came to my notice, my impression was that water gas was so practically dangerous (on account of the large amount of carbonic oxide in it), that it should not be admitted into general use; but further consideration modified this view to the belief that "it would be a question of economy and efficiency simply, whether water gas did or did not become the gas of the future."

[Report of Prof. Henry Morton, December 8, 1879.]

You will see that I not only agree with Prof. Wurtz in considering carbonic oxide as rendering all gases which contain it more or less dangerous, but also regarded the danger from any gas as so small, and modified by so many other conditions, that this question need not, and undoubtedly would not, influence the practical adoption of any gas for domestic uses, provided it were otherwise desirable.

It is a well known fact that many of the cities of Europe are supplied with gas made from wood, and containing, according to Dr. Wurtz, from 27 to 32 per cent. carbonic oxide.

The gas at Berlin is made from lignite, or brown coal, and contains 40 per cent., and the gas at Munich, Bavaria, 40.5 per cent. of carbonic oxide. (See Prof. Chandler's article in Johnson's Encyclopedia, vol. ii, p. 450.)

No facts can be produced to prove that suffocation by coal gas would not as certainly result, if it is inhaled under the same conditions which have existed in cases of suffocation by water gas.

LIST FURNISHED BY FULTON MUNICIPAL GAS COMPANY.

SUFFOCATION BY COAL GAS.

NAME.	DATE.	PLACE.	AUTHORITY.
William Drummond...	Oct. 28, 1880	311 E. 11th st., New York.	Times.
John Smith............	Apl. 11, 1881	395 Bowery, New York ...	Times.
Peter Kerrollhoff	Nov. 9, 1881	334 Bowery, New York....	Telegram.
Patrick Georgeeghan.	Feb. 5, 1882	226 E. 11th st., New York.	S'nd'y Mercury.
Louis McCann and wife	Nov. 14, 1882	Astor Place Hotel, 8th st. and 4th avenue	Times.
John Donovan	May 23, 1880	115 W. 32d st., New York.	Coroner's Office.
Lorenzo Mundy.......	Nov. 10, 1878	21 E. 4th st., New York...	Coroner's Office.
John Brown	Nov. 8, 1878	31 Bowery, New York....	Coroner's Office.
Alex Miller	May 1, 1874	51 E. 10th st., New York..	Coroner's Office.
Sophia Heally.........	Dec. 9, 1873	E. 86th st., bet. 1st and 2d avenues, New York.....	Coroner's Office.
H. H. Gerland	Feb. 28, 1872	22 E. 1st st., New York ..	Coroner's Office.
Jane A. Croubett	May 19, 1871	111 W. 26th st., New York.	Coroner's Office.
M. Newman	Apl. 9, 1871	New England Hotel, Bowery, New York	Coroner's Office.
Donald Stewart.......	Mch. 29, 1871	Putnam House, 4th avenue and 26th street.....	Coroner's Office.
John Loughlin........	Jan. 31, 1871	1,497 3d ave., New York ..	Coroner's Office.
Bernard Loughlin.....	Jan. 31, 1871	1,497 3d ave., New York ..	Coroner's Office.
Ann Loughlin..........	Jan. 31, 1871	1,497 3d ave., New York ..	Coroner's Office.
Susanna M. Wallace...	Jan. 25, 1882	362 Pearl st., B'klyn, N. Y.	Board of Health.
Thomas Wallace	Jan. 25, 1882	362 Pearl st., B'klyn, N. Y.	Board of Health.
Catharine Ryan — four children	Dec. 19, 1878	Randolph, Mass..........	N. Y. paper.
August Bolle.	Nov. 17, 1878	Buffalo, N. Y	Herald.
W. H. Metcalf and son.	Nov. 30, 1878	Blackstone, Mass.........	Evening Post.
Gabriel Castro	Nov. 20, 1878	San Francisco, Cal	Courier.
John Scrafford	Mch. 18, 1879	Bath, Me	Telegram.
Frank W. Tucker	Mch. 18, 1879	Providence, R. I..........	Telegram.
Jas. Hanna and friend.	Sept. 30, 1880	Stradesburgh, Pa.........	Times.
Mlle. Thauberg	Dec. 12, 1880	Paris, France	Times.
Esther Burton	Apl. 11, 1881	Albany, N. Y	N. Y. paper.
John Hopkins	Apl. 11, 1881	Chicago, Ill...............	N. Y. paper.
F. Tilford and wife....	Nov. 19, 1881	Philadelphia, Pa	Telegram.
Annie Buck..........	Oct. 14, 1882	Jersey City, N. J	Times.
W Toland.............	Nov. 18, 1882	Batavia, N. Y	Times.
Isaac Batten	Dec. 27, 1882	Philadelphia, Pa	Tribune.
Frank Hayes	Mch. 2, 1882	Boston, Mass	Herald.

For evidence as to injury and death caused by inhalation of coal gas, see cases cited by "Greenough Digest," 1883.

Page 120, Holley vs. Boston Gaslight Company.
121, Smith vs. Boston Gaslight Company.
119, Hunt vs. Lowell Gaslight Company.
119, Holley vs. Boston Gaslight Company.

APPENDIX E. PAPER 10.

FULTON MUNICIPAL GAS COMPANY,
OFFICE, 342 FULTON STREET, Corner Boerum Place,
BROOKLYN, July, 1882.

The company is supplying gas to consumers on the line of its street mains on as favorable terms as any other company.

The superiority of the gas made by this company is established by the fact, that within a short time the sales of gas made by a similar process in New York have reached nearly one-half of the total amount consumed there. Almost all of the best hotels, theatres, hospitals, public buildings and private dwellings take it. It is more brilliant than any other gas, and the testimony of professors of chemistry and medicine in the United States, England and France, whose authority is unquestioned, is decisive, that "it contains less impurities," that the "product of its combustion are less objectionable than those of gas made from gas coal," and that it may be used with safety both in public and private houses.

Therefore, no attention should be given to any statements to the contrary, circulated to injure our business.

This company is supplying a large portion of the gas used in Brooklyn, is extending its works and mains, and respectfully requests the patronage of the public.

Consumers get one-third more light for the same price paid for other gas, and for equal light can reduce their bills to that extent.

Applications received by our canvassers, or at the office of the company.

No charge made for putting in service pipes and meters.

We present the following extracts from the reports of professors of chemistry and medicine of the highest authority, who have examined the gas made by our process. Copies may be seen at the office of this company:

[R. Ogden Doremus, Professor of Chemistry and Toxicology, Bellevue Hospital Medical College, New York.]

" Having been informed that parties are circulating reports that the gas furnished by your company is particularly poisonous, and having been requested to express an opinion on this subject, I beg leave to state that the trivial variations in the gases made by different processes is of no importance in regard to health,

excepting as to the products of their combustion. In this respect your gas is superior to all others, as it does not contain impurities existing in gas manufactured from bituminous coal."

[E. Frankland, Professor of Chemistry, Royal College of Chemistry, South Kensington Museum, London, England.]

"I have no hesitation in saying that it may be used with safety both in public and private houses. I should be delighted to substitute this pure and powerful agent for the gas with which my house in London is at present supplied."

We have also reports from Henry Wurtz, Ph. D., of Hoboken, N. J., and Ad. Wurtz, Membre de l'Institut, Professeur à la Faculté de Médicine et à la Faculté des Sciences, Paris, France, confirming the statement that the products or effects of burning this gas are less objectionable, to a marked extent, than with gas from gas coal.

Prof. Henry Morton, Stevens Institute of Technology, Hoboken, N. J., who has been quoted as having denounced the use of this gas, says, in a report which we have: "You will see that I not only agreed with Prof. Wurtz in considering carbonic oxide as rendering all gases which contain it more or less dangerous, but also regarded the danger from any gas as so small, and modified by so many other conditions, that this question need not and undoubtedly would not influence the practical adoption of any gas for domestic uses, provided it were otherwise desirable."

REPORT OF PROF. C. F. CHANDLER, PRESIDENT OF THE BOARD OF HEALTH, TO THE BOARD OF ALDERMEN, CITY OF NEW YORK.

The President laid before the Board the following communication from the Board of Health :

HEALTH DEPARTMENT,
NEW YORK, April 15, 1881.

To the Honorable the Board of Aldermen :

At a meeting of the Board of Health, held on the 13th inst., the following report of the President was unanimously adopted, and a copy was ordered to be forwarded to your Honorable Body :

REPORT.

I have the honor to report that the petition of citizens referred to the Board of Health by the honorable the Board of Aldermen, with regard to the illuminating gas which is manufactured from steam, anthracite coal and naphtha, the so-called water gas, has been duly considered.

This gas has been extensively used in the City of New York for some years, in public and private buildings. While it differs somewhat in composition from the gas manufactured from bituminous coal, it involves in its careless use the same sources of danger; if allowed to escape into the air without being burned it produces an explosive mixture with the air, and it is also liable to suffocate persons who may remain for any length of time in the atmosphere thus contaminated. There are no facts which give any substantial foundation for the apprehensions of the petitioners that this gas is in any way more dangerous than the gas previously in use. I would further state that the allegation that this water gas has been prohibited in Paris is directly denied by Professor Adolph Wurtz, of that city, in a letter which I have before me; that the greater density of the gas causes it to escape more slowly from leaks than does ordinary coal gas, and that its odor is so decided that leaks are detected just as readily as in the case of other gas. In conclusion I would say I see no reason why any official action should be taken on this subject.

(A true copy.) C. F. CHANDLER,
President.

——— ———, Secretary.

Which was referred to the Committee on Police and Health Departments.

FULTON MUNICIPAL GAS COMPANY,
342 FULTON STREET, COR. BOERUM STREET,
BROOKLYN, October 1st, 1880.

This company is supplying to consumers on the line of its pipes the best illuminating gas ever made. This gas gives one-third more light per 1,000 cubic feet than other gas. The Municipal Gaslight Company of New York, and the New York Gaslight Company—the oldest company there—are using the same process that we have, and are sending out more gas than the total amount of all kinds consumed in Brooklyn.

Experience proves that it is much better and cheaper than any other gas, saving from 20 to 30 per cent. in cost for equal light. We shall endeavor to make our business intercourse entirely satisfactory to our customers, and we respectfully solicit the patronage of the public.

Application may be may made from residents on the line of our street mains to our solicitors who may call, or at the office of the company.

We present the following extracts from the reports of professors of chemistry and medicine of the highest authority, who have examined the gas made by our process. Copies may be seen at the office of this company:

[R. Ogden Doremus, Professor of Chemistry and Toxicology, Bellevue Hospital Medical College, New York.]

"Having been informed that parties are circulating reports that the gas furnished by your company is particularly poisonous, and having been requested to express an opinion on this subject, I beg leave to state that the trivial variations in the gases made by different processes is of no importance in regard to health, excepting as to the products of their combustion. In this respect your gas is superior to all others, as it does not contain impurities existing in gas manufactured from bituminous coal."

[E. Frankland, Professor of Chemistry, Royal College of Chemistry, South Kensington Museum, London, England.]

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Prof. Chandler, President of the Board of Health, New York, is using this gas in his house, and many physicians in New York and Brooklyn have adopted it. The decided superiority

and economy of this light is such that now, within three years of its introduction in New York, forty per cent. of all the gas used there is made by this process, and principally in the best hotels, theatres and public buildings.

H. M. BENEDICT,

President.

SCHOOL OF MINES, COLUMBIA COLLEGE,
COR. 49TH STREET AND 4TH AVENUE,
NEW YORK, December 28, 1877.

MR. CHAS. G. FRANCKLYN,

President of the Municipal Gaslight Company.

DEAR SIR: It has lately come to my knowledge that parties, whose interests were affected by the rapid developments of your company, have been circulating rumors calculated to prejudice people against the use of your gas. Not knowing the extent of your information respecting this, and deeming it of importance that you should know exactly how your gas compares with others used for illuminating purposes, I take the liberty to address to you the following: During the past half dozen years (of which two were spent under the personal guidance and instruction of the eminent chemist, Prof. Bunsen, in the Heidelberg, University, Germany), devoted to the study of Chemistry of Illuminating Gas, it has not been my fortune to examine a single gas possessing so many intrinsically fine qualities for the purpose of illumination as I find in yours.

1st. Its pure brilliancy and illuminating power far surpasses the ordinary coal gas flame, and equals the renowned Boghead and cannel coal gases of Scotland. and is most easily distinguished by the indifferent observer, from gas by the old methods. This is mostly due to the fact that by the old processes even of the above-named Scotland coals, as much as thirty-three per cent. of the coal becomes tar during the process of manufacture, some of which is dissolved by vapors in the gas, and by them are carried to the consumer's burner, rendering the flame brown-bordered and smoky.

2d. Respecting the purity of the gas, there is no room for question, for in its normal condition I find it composed of fixed gases like air, unchanged by heat and cold, and almost absolutely free from gummy vapors which are constantly such a great detriment in the old processes, because of their being influenced by change of temperature and contact with metallic surfaces, causing

them to deposit the tarry substances that were held in solution, and also from sulphur compounds, which in ordinary gas is so apt to be abundant, and which after burning, so greatly vitiate the air, and so destructively corrode chandeliers, bronze ware, and polished metallic surfaces.

3d. As regards the effects of its use on health, my seven months' personal experience and practical tests from six to eight hours daily with it in a little laboratory, closed so as to exclude currents of air that would otherwise destroy my analytical work, where from five to fifteen feet per hour are used without noting one single effect, is to me conclusive proof of the fallacy of ascribing to it a single detrimental property ; besides, as I understand, millions of cubic feet have been manufactured by your company and sent out to consumers, and used in the largest and best hotels, public places of entertainment, and private dwellings in this city, without a single complaint, thus fully corroborating my own experience.

Very respectfully yours,

H. C. BOWEN,

Assistant in Analytical Laboratory, School of Mines, Columbia College,

To Charles G. Francklyn, Esq.,

President of the Municipal Gaslight Company :

Sir : I have had the honor of receiving from you a letter, in which you desire replies to two questions, and call my attention to certain recent public statements and discussions bearing upon your new manufacture of illuminating gas with a basis of water gas. I beg to reply as follows :

First question : Whether I deem the gas made by your company as more dangerous, in case of leakage, than that made from gas coal ?

I understand here that the point involved is the reliability of the assertions brought forward in the discussions above referred to, as to the extremely poisonous nature of carbonic oxide, an ingredient said to be contained in your gas more largely than in that from gas coal.

It is now many years since I examined the facts on record relating to the action of carbonic oxide upon the human system. It is well known that among American chemists I have for ten years—including the period of my editorship of the "American Gaslight Journal"—stood virtually alone as a declared advo-

cate of the introduction of water gas for domestic uses. I did not take this stand without having satisfied myself that carbonic oxide is not—as popularly believed—an exceptionally poisonous gas. Since receiving your letter, I have again partially reviewed the literature of the subject, and am again confirmed in my conclusion that whatever dangers to life and health may or do arise from the use (or rather abuse) of illuminating gases, these will not be enhanced in any way by an increase in its proportion of carbonic oxide.

The real practical question is not whether carbonic oxide is poisonous, but whether it is more poisonous or dangerous, under like circumstances, than gas from gas-coal. In this brief letter it is of course impracticable to discuss the subject in full, or even to cite the numerous facts stated and results of actual experiments made by eminent authorities bearing thereon. This may be done hereafter in a more extended report. The general conclusion to which these facts have led me, is one to which they will be found, when taken collectively, to lead other unprejudiced minds I may present some concise statements:

Carbonic oxide, when inhaled undiluted, is a gas which has peculiar and rapid effects upon the nervous system; comparable in the case of man with those of chloroform, though the symptoms are more rapid, both in appearance and disappearance. The anæsthesia produced is, however, oftener than in the case of chloroform, preceded by a transient stage of excitement or intoxication, accompanied by violence.

During anæsthesia, as with chloroform, continued inhalation is very dangerous; doubtless more so than with the latter. Pure carbonic oxide has been, nevertheless, proposed and used safely as an anæsthetic agent upon man as well as upon lower animals, some twenty years ago, by Ozanam and Tourdes, both these famous authorities comparing the symptoms to those of chloroform.

When used purposely as a fatal poison upon animals in comparison with gas from gas-coal, Leblanc and Tourdes found that twelve per cent. mixed with air killed rabbits in seven minutes, while Tourdes also found that two per cent. of coal gas killed such animals in twelve minutes. Devergie, Tourdes and Adolphe Wurtz all agree that nine per cent. of coal gas in air will prove fatal to man, while Tourdes states also that six per cent. of the same killed rabbits in a few minutes.

When largely diluted with air, however, the effects of carbonic oxide on man appear, from very extensive observation, to be very uncertain, and at the worst, but transient. Headaches, indicating slight nervous disorder, appear to be the only lasting symptoms. Such headaches are familiar to those who live in houses heated with anthracite, whether by stoves or furnaces. In these cases, nevertheless, the effect of carbonic oxide is so usually complicated with those of the far more poisonous gases, sulphuretted hydrogen and sulphurous acid, that the imputation of the symptoms observed to carbonic oxide solely, is by no means justifiable.

As to the dangers that have been imagined, of poisonous or even seriously injurious impregnation of the air of dwellings or rooms by any supposable leakage of your gas—assuming it to be one-fourth carbonic oxide—a little arithmetic at once proves it to be altogether a chimera. A leak of one cubic foot per hour would be a very large one, especially of your very dense gas (density 700), and would be immediately detectable by the odor. In a medium sized bedroom, of say 15 by 10 by 10 feet, containing 1,500 cubic feet, this would impart, during a night of eight hours, two cubic feet of carbonic oxide, or $\frac{1}{750}$th part—a wholly inappreciable proportion.

A wide open three foot burner would emit into such a room in eight hours six cubic feet of carbonic oxide, or (if the room were air-tight) two-fifths of one per cent. In less than eight hours, however, a similar emission of some illuminating gases (carrying hydrocarbons) would reduce a sleeping occupant to a state of helpless narcotism. The absurdity of attributing such occurrences as this to the carbonic oxide alone, is here apparent. The conditions here supposed are nevertheless so exceptional as to have no reasonable bearing one way or the other. A person of idiotic turn of mind, who would blow out a gas-burner, would also—still more probably—leave off the top of an anthracite stove, and go to sleep with it as a room-mate; stoves and furnaces, through accident or defect, often emit carbonic oxide (with worse gases, as aforesaid) into our dwellings to a far greater extent than could proceed from any leak in your service pipes. Yet stoves and furnaces are not practically condemned for this. Their economy and convenience, with management of average intelligence, over-balance such occasional detrimental results.

Repeated visits to water-gas works, and questioning of the employees therein, have justified to me the views above expressed. In your own works I find that employees maintain that the effect

of the gas upon the nerves, after it has been "carburetted," or enriched with naphtha, is much more rapid than before, although the proportion of carbonic oxide is thus largely diminished; a fact which demonstrates at once the view long held by me, that the toxical constituents of illuminating gases are mainly the hydrocarbons present, and not the carbonic oxide. My reply to your first question is an emphatic negative.

Second question: Whether the products or effects of burning your gas are more objectionable than with gas from gas-coal?

To this I reply that, on the contrary, they must be less objectionable to a marked extent.

This question was examined by me ten years since. The results were then made public, and belong to the literature of the subject. It was shown that an illuminating gas with a basis of water gas, yielded on burning less water and carbonic acid, and consumed less of the oxygen of the air, for equal volumes, than an average gas of less candle power, made from gas-coal. Here there is, however, an additional important point.

For equal volumes your gas is over 40 per cent. heavier, and yields some 40 per cent. more light than gas from good caking coal. Deferring precise calculations for the present, it may be briefly stated that the vitiation of the air of a room, for equal amounts of light, could not with your gas be more than two-thirds of that with the purest gas made from coal; at least one of the statements to the contrary, which has been widely circulated of late, appears to have been founded on a strange forgetfulness of the familiar chemical laws, that both marsh gas and carbonic oxide yield in burning, the same volume of carbonic acid, while carbonic oxide consumes but one-fourth as much oxygen as marsh gas, which latter is more largely contained in gases made from gas-coal.

Respectfully,

HENRY WURTZ, *Ph. D.*

No. 12 Hudson Terrace, Hoboken, Jan. 1, 1878.

APPENDIX E. PAPER 11.

WATER GAS—IS IT MORE DANGEROUS IN ACTUAL USE THAN COAL GAS?

A pamphlet is being industriously circulated in various cities, containing statements to the effect that water gas is particularly dangerous because of the carbonic oxide it contains, and we see that great prominence is given to the opinion once held by Prof. Henry Morton, Ph. D., President Stevens Institute of Technology, Hoboken, N. J.

Now there are two sides to every question, and if any one has been misled by the overdrawn statements in the pamphlet referred to, we ask their attention to what follows.

And we will begin the other side of the story by quoting Prof. Morton ourselves. In a letter to the "Plumber and Sanitary Engineer" of New York, January 15, 1880, he says:

"I am quite ready to admit that when the subject first came to my notice, my impression was that water gas was so practically dangerous (on account of the large amount of carbonic oxide in it), that it should not be admitted into general use, * * * but further consideration modified this view," to the belief that "it would be a question of economy and efficiency simply, whether water gas did or did not become the gas of the future."

The pamphlet contains a wearisome list of quotations compiled (before he had revised his opinions as above) by Prof. Morton for the "American Gaslight Journal," in 1878. And on this general subject we quote from the eminent chemist, Prof. Henry Wurtz, Ph. D., of Hoboken, N. J., as follows:

"No accumulation of citations of vague and crude opinions, stereotyped through generations of school books, as to the danger of small percentages of carbonic oxide in air should have any influence on reasonable minds, when it is only by rare accident or stupidity that even these small percentages can be communicated to the air of a close room. I am confirmed in my conclusions, that whatever dangers to life and health may or do arise from the use (or rather abuse) of illuminating gases, these will not be enhanced in any way by an increase in its proportion of carbonic oxide."

Water gas was introduced in New York city in 1877 by the Municipal Gaslight Company, and early in 1878 Dr. Henry Wurtz made two exhaustive reports giving the results of his scientific analysis. About this time Prof. Morton's articles,

above referred to, came out in the "American Gaslight Journal" of New York, (a paper wedded to coal gas interests, and whose name should be changed to the "American Coal Gaslight Journal"), and it gave much comfort to the coal gas people who hoped thereby to stay the progress of water gas.

Now in order to satisfy the public that the gas they were furnishing was entirely safe, the Municipal Company sent all these papers to the two most eminent chemical authorities in the world, Dr. E. Frankland, of London, and Dr. Adolphe Wurtz, of Paris, and we gladly quote their replies in full:

Royal College of Chemistry,
South Kensington Museum,
London, May 6, 1878.

Sir:

In compliance with your request, I have read the reports of Dr. Henry Wurtz, dated January 1, 1878, and March 4, 1878, on the composition and properties of the gas of the Municipal Gaslight Company of New York, and also the articles published by Prof. Henry Morton in the "American Gaslight Journal" of March 2 and 16, 1878; and having been called upon to express my opinion as to the adaptability of water gas for lighting and heating purposes, I have no hesitation in saying that it may be used with safety, both in public buildings and private houses. I should be delighted to substitute this pure and powerful illuminating agent for the gas with which my house in London is at present supplied, although it is used in all the bedrooms.

[Signed] E. FRANKLAND.

To Charles G. Francklyn, Esq.,
Pres. Municipal Gaslight Company of New York:

Paris, June 12, 1878

Sir:

I have read with attention and interest the documents concerning the gas of the Municipal Gaslight Company of New York, which you have forwarded to me.

I have acquainted myself with the extensive and exact work which Dr. Henry Wurtz has published about the composition and use of the gas. Produced by the decomposition of steam on incandescent carbon, and saturated with very volatile hydrocarbons obtained from petroleum, the gas possesses an intense illuminating power, a marked smell and a sufficient density. I have been struck with the correctness of the

remarks which terminate the report of Dr. H. Wurtz, and which, in my opinion, answer the objections formulated by Dr. Henry Morton, inserted in two articles in the "American Gaslight Journal," published in New York. No doubt the danger of poisoning exists with all gases containing carbonic oxide, and coal gas is not exempt from the latter, as it can contain as much as 12 per cent of its volume. But I think that the danger, which could only have sad consequences in exceptional cases and through a sort of fatality, has been exaggerated, and should not be taken into account, considering that gas is used without hesitation for lighting our houses, notwithstanding the very real danger of explosion and fire, no matter what kind of gas or its composition.

Further, the use of water gas has never been prohibited in France, and if the numerous processes which have been indicated for its production have been abandoned or have received only a restricted application, the cause is principally due to the circumstance that the technical and economical conditions of the production have, up to the present time, been very unfavorable.

In manufacturing, under good conditions, a gas remarkable on account of its illuminating power and of a sufficient smell to reveal its presence, you have realized an important progress.

It would appear to me unjust to deprive you of your useful discovery.

[Signed] ADOLPHE WURTZ,

Member of the Institute, Professor at the School of Medicine, and the School of Sciences.

To Charles G. Francklyn, Esq.,

President, Municipal Gaslight Company of New York.

It is stated in the pamphlet, time and again, that the manufacture of water gas was prohibited in France and on the continent. Please notice that in the above letter of Dr. Adolphe Wurtz, this statement is flatly contradicted, so far as France is concerned; and it is a well known fact that many of the cities of Europe are supplied with gas made from wood, and containing, according to Dr. Wurtz, from 27 to 32 per cent of carbonic oxide.

The gas at Berlin is made from lignite, or brown coal, and contains 40 per cent, and the gas at Munich, Bavaria, 40.5 per cent of carbonic oxide—see Dr. C. F. Chandler's article in Johnson's Encyclopedia, vol. ii, page 451.

And just here we are glad to again quote Prof. Morton, who, in an article on water gas in the "Plumber and Sanitary Engineer" of New York, December 8, 1879, in which he coincides with the above opinion of Dr. Wurtz, says:

"You will see that I not only agree with Prof. Wurtz in considering carbonic oxide as rendering all gases which contain it more or less dangerous, but also regarded the danger from any gas as so small and modified by so many other conditions that this question need not and undoubtedly would not influence the practical adoption of any gas for domestic uses—provided, it were otherwise desirable."

The pamphlet asserts that water gas is not only poisonous but that the products of combustion are more dangerous than from coal gas. On these points see what is said by Dr. R. Ogden Doremus, Professor of Chemistry and Toxicology, Bellevue Hospital Medical College, New York:

"Having been informed that parties are circulating reports that water gas is particularly poisonous, and having been requested to express an opinion on this subject, I beg leave to state that the trivial variations in the gases made by different processes is of no importance in regard to health, excepting as to the products of their combustion. In this respect water gas is superior to all others, as it does not contain impurities existing in gas manufactured from bituminous coal."

Regarding the comparative safety of coal gas and water gas, Prof. T. Sterry Hunt, of Montreal, writes:

"I must say, however, that the notion of any important difference in the safety or fitness for use of two such gases seems to me to be absurd. The only questions to be raised are the relative cheapness and illuminating power."

We referred the question as to whether carbonic oxide is an objectionable element in water gas to Dr. Gideon E. Moore of New York, the eminent analytical chemist, and received the following reply:

"I consider carbonic oxide to be a highly desirable ingredient in water gas; its density and high flame temperature greatly promotes the illuminating effect and retards waste."

In 1881, certain parties interested in coal gas got up a petition to the Board of Aldermen of New York, making the usual assertions that water gas is more dangerous than coal gas, and praying that its manufacture be prohibited. This communication was referred to the Board of Health with the following results, and as Dr. Chandler is perhaps the highest chemical authority in this country, we ask especial attention to his opinion:

Report of Dr. C. F. Chandler, President of the Board of Health, to the Board of Aldermen, city of New York:

The President laid before the Board the following communication from the Board of Health:

HEALTH DEPARTMENT, NEW YORK, April 15, 1881.

To the Honorable the Board of Aldermen:

At a meeting of the Board of Health held on the 13th inst., the following report of the President was unanimously adopted, and a copy was ordered to be forwarded to your Honorable Body:

REPORT:

I have the honor to report that the petition of citizens referred to the Board of Health by the Honorable the Board of Aldermen, with regard to the illuminating gas which is manufactured from steam, anthracite coal and naphtha,—the so-called water gas—has been duly considered.

This gas has been extensively used in the city of New York for some years in public and private buildings. While it differs somewhat in composition from the gas manufactured from bituminous coal, it involves, in its careless use, the same sources of danger. If allowed to escape into the air without being burned, it produces an explosive mixture with the air, and it is also liable to suffocate persons who may remain for any length of time in the atmosphere thus contaminated.

There are no facts which give any substantial foundation for the apprehensions of the petitioners that this gas is in any way more dangerous than the gas previously in use. I would further state that the allegation that this water gas has been prohibited in Paris, is directly denied by Prof. Adolphe Wurtz, of that city, in a letter which I have before me, that the greater density of the gas causes it to escape more slowly from leaks than does ordinary coal gas, and that its odor is so decided that leaks are detected just as readily as in the case of other gas. In conclusion I would say I see no reason why any official action should be taken on this subject.

[Signed] C. F. CHANDLER,

President.

Which was referred to the Committtee on Police and Health Departments.

The general question as to whether water gas is a safe and desirable illuminant was referred by the Mayor of New Orleans to Dr. Joseph Jones, President of the State Board of Health, with the following reply:

New Orleans, August 9, 1880.

Hon. I. W. Patton, *Mayor of the City of New Orleans:*

Sir:

In reply to the communication of your Honor of the 6th ult., propounding certain inquiries with reference to the chemical composition, poisonous properties, and relative value of water gas, I respectfully submit the following outline of the results of my investigation:

* * * * * * *

1. Its pure brilliancy and illuminating power far surpasses the ordinary coal gas flame and equals the renowned B and cannel coal gases of Scotland.

2. Respecting the purity of the gas, it is composed of fixed gases like air unchangeable by heat and cold, and almost absolutely free from gummy vapors which are constantly such a great detriment to the old process.

3. As regards the effects of its use on health, those who have used the gas most extensively testify to the fact that it is in no manner dangerous, and is as safe in this respect as ordinary coal gas.

4. The products or effects of burning the water gas are less objectionable than with gas from gas coal. An illuminating gas with a basis of water gas, yields in burning less water and carbonic acid, and consumes less oxygen of the air for equal volumes than any average gas of less candle power made from pure gas coal.

From the preceding facts we conclude:

1. Water gas is superior to the ordinary coal gas in heating and illuminating power.

2. Water gas can be furnished at less cost to the consumer than ordinary gas.

3. Water gas is not more dangerous in case of leakage than that made from gas coal.

4. The products or effects of burning water gas are less objectionable and less injurious than those arising from the combustion of coal gas.

Respectfully,

[Signed] JOSEPH JONES, M.D.,

President Board of Health, State of Louisiana.

In 1879, the Consumers' Gas Company of Toronto, up to that time making coal gas, changed its works to the Lowe water gas system, and soon after the usual opposition was made by parties in the coal gas interest, and the question of the safety of water gas was referred to the two leading chemists of the city.

Dr. H. H. Croft, late Professor of Chemistry, University College, Toronto, made a lengthy report, in which we find these words:

"In conclusion, I may say that the gas made by the Lowe process, or from coal, may be used indifferently, with proper precautions and common sense, and that the one is not on the whole more dangerous than the other, nor nearly so much so as the oil employed in our lamps."

Dr. W. H. Pike, Professor of Chemistry, University College, Toronto, wrote:

"The city gas, as at present supplied is, if used with the ordinary precautions necessary in the case of coal gas, free from all practical danger. As to the comparative danger to life of an open tap or leak in a bedroom in the case of coal gas and Lowe gas, I think that there can be no great difference."

One phase of the opposition at Toronto was the assertion that in the two years ending 1880, there had been 11 deaths from poisoning by water gas in New York City. Now, at the instance of Mr. W. H. Pearson, Secretary of the Toronto Company, this statement was carefully investigated, and inquiry at the Coroner's office and at the places where the deaths occurred, developed the facts that:

Three were suicides, the persons deliberately stopping the keyhole, and putting rugs at the bottom of the door, and unscrewing the gas bracket.

Three were caused by explosions at gas works. (The record does not state the kind of gas in above six cases.)

Two were by accidental suffocation with coal gas, and

Three by accidental suffocation with water gas.

It is thus seen, to put it mildly, that when facts are wanting the imagination is freely drawn upon.

The following is a copy of the analysis of the Lowe water gas at Baltimore:

	Constituents.	Vols. per 100.
	Hydrogen	46.49
	Marsh Gas	11.75
	Carbonic oxide	21.51
	Nitrogen	4.30
	Oxygen	.20
Olefine Gases.	Ethylene	6.50
	Propylene	.35
	Butylene	.15
Paraffine Gases.	Ethane	.50
	Propane	1.00
	Butane	7.25
		100.00

which we sent to Dr. E. G. Love, Analytical Chemist and Official Gas Examiner of New York City, and asked an expression of his opinion with special reference to carbonic oxide. His reply is as follows :

New York, Jan. 31, 1883,

Messrs. A. O. Granger & Co., Philadelphia,

Gentlemen :

Yours of the 30th inst. is at hand. In reply I will say that I think the only questions relative to water gas that need be considered by any gas company, are the economy of production and quality of the light. I do not consider the presence of carbonic oxide in illuminating gas as objectionable.

I might add that in 1879 the Municipal Company of this city made 550,000,000 cubic feet of the so-called water gas, and in May, 1880, the New York Company adopted the same process, and I have no doubt that the present yearly consumption of water gas in this city is over one billion cubic feet.

Yours truly,

[Signed] E. G. LOVE, *Ph. D.*

Comparing water gas with coal gas two plain questions were asked Prof. Henry Wurtz as to the danger from products of combustion and from leakage, and we quote herewith both the questions and answers in full :

"Question—Are the products of combustion of the Lowe water gas, when in use, more or less deleterious to health than those of gas from gas coal?"

"The answer to this question must be qualified by assuming it to apply to gases of like candle power. In this case it is a matter of chemical demonstration that the amount of carbonic acid formed by the Lowe gas when burning, the amount of aqueous vapor formed, and the amount of atmospheric oxygen consumed or destroyed, are all three very considerably less than in the case of gas from gas coal. The effects upon the atmosphere of rooms, equally lighted with the two gases, tell, therefore, considerably in favor of the Lowe gas."

"Question—Whether, in the event of leakage in dwellings, the Lowe water gas is more dangerous or less dangerous to life and property than ordinary coal gas?"

"The dangers from leakage of gas are two in kind: 1st. From suffocation by inhalation. 2d. From explosion and fire. Of these the last is much the most common and the most serious, involving injury to both property and life. Indeed, suffocation rarely or almost never arises from ordinary (accidental) leakage; but mostly from inexcusably culpable negligence or ignorance. Facts on record support strongly the belief that variation in composition of illuminating gases has little or no appreciable influence on its suffocating quality. The most narcotic agents present are the illuminating hydrocarbons, and a small percentage of these in air is always dangerous to life, by reason of the rapid anæsthesia which follows their inhalation; and carbonic oxide is also a powerful anæsthetic, but not more so than these heavy hydrocarbons, on which the illuminating value of all gases depends.

"As to the explosiveness of the two gases, however, and the danger arising therefrom, the new gas has a decided advantage. Carbonic oxide is a gas whose explosive power for equal volumes is far smaller than that of marsh gas, a main constituent of ordinary gas coal gas. This is because in exploding marsh gas consumes four times as much oxygen as carbonic oxide. The introduction of the Lowe gas must therefore be attended with diminution of risks to life and property.

[Signed] HENRY WURTZ, *Ph. D.*"

The statement is gravely made in this remarkable pamphlet we have been commenting upon, that "water gas is more danger-

ous than coal gas because it is about twice the specific gravity of coal gas, and is heavier than air, and so in case of leaks will fall to the floor and not be noticed as quickly as coal gas which has a more intense odor."

All of which is simply false. Water gas smells worse even than coal gas and its presence can be instantly detected by the smell when so small a quantity as one ten thousandth part has escaped into the air of a room. It is but litle heavier than coal gas, its specific gravity being .570 while coal gas is .470, air being called 1.000 and taken as the standard. And so instead of being heavier than air it is but little more than half its weight; and as a matter of fact the writer has made an ascension in a balloon filled with pure water gas.

Three years ago we wrote Dr. Moore, of New York, one of the most prominent gas chemists of the country, as to the cause of the strong smell of illuminating water gas, and also relative to the products of combustion, and he replied as follows:

DR. GIDEON E. MOORE, ANALYTICAL AND CONSULTING CHEMIST,
69 Liberty Street.
NEW YORK, May 18, 1880.

Messrs. A. O. Granger & Co., 22 and 24 North Fourth Street, Philadelphia:

GENTLEMEN:

* * * The pungent odor of water gas, after being charged with illuminants, is entirely due to the presence of volatile hydrocarbons, formed by the decomposition of the petroleum used in making it. This odor, far from being a disadvantage, is, in reality, a special advantage of water gas, inasmuch as it makes it very easy to detect leakage in the pipes.

All illuminating gases are, in themselves, more or less poisonous, and that gas is to be pronounced the safest that can most readily be detected by the odor. The more insupportable the odor the greater will be the impulse to avoid inhalation, and the more certainly will leakage be attended to. It is not, in my opinion, desirable to attempt to abate this odor. It does not result from imperfect purification or through any fault in making the gas, but it is a necessary result of the process of manufacture, as well as a most valuable property of the product.

The products of combustion of water gas are absolutely inodorous; the air in the room in which it is burned is altered solely by absorption of oxygen and the formation of carbonic acid, phenomena that are inseparable from all forms of combustion, whether of gaseous, solid, or liquid illuminating material.

Very respectfully yours,

[Signed] GIDEON E. MOORE, *Ph. D.*

From all this talk about carbonic oxide one might take it to be a newly discovered gas, but in reality it is the same gas that escapes from our stoves and ranges and heaters, after a fresh lot of coal has been thrown on the fire, if the proper damper is not opened so as to let it escape up the chimney. Does any one think of objecting to the use of stoves and of coal or coke because occasionally, through thoughtlessness or stupidity in regulating the dampers, the coal gas of the housekeeper escapes into the room?

We could, without difficulty, compile from musty technical works, as well as from living authorities, a great list of facts proving the deadly narcotic effect of the component parts of coal gas, but this would not be to the point.

Illuminating gas made from bituminous coal is highly charged with the deadly fire-damp of the coal mine, which is simply marsh gas or light carburetted hydrogen, and is present in coal gas to the extent of 46 per cent, while water gas contains but 12 per cent.; but we do not on this account attempt to raise a hue and cry against coal gas, because any danger attending its use is very remote, and is simply the result of dense ignorance or gross carelessness.

Opposition to the march of improvement has been the rule in all ages, either from motives of self interest of the few or fondness for the old beaten paths, and with reference to the introduction of coal gas early in the present century we find that, in combating the prejudice and ignorance of the day, it was quite as long in gaining public favor as water gas has been.

The first proposals to light a town with coal gas were made in England as early as 1765, but it was not practically applied for lighting until 1792, when William Murdock lighted his own house with it in Cornwall. A gas company was not formed in London until 1810. Paris was not lighted with gas until 1820, New York until 1834, and Philadelphia until 1835.

Much opposition and prejudice had to be overcome before it was generally adopted, and as an instance of this there is on record a petition from a large number of influential citizens of Philadelphia, dated 1830, setting forth a great number of evils and calamities that would inevitably follow its introduction there, owing to its "poisonous, explosive and destructive nature, and praying the Government to prohibit it."

History repeats itself! How much this sounds like the present opposition to water gas!

One of the early objections to gas in England was the danger from fire, the belief being current that the gas was distributed in an ignited state. On this point we find the following in Clegg's work on coal gas:

"It was generally believed that the pipes carrying the gas must be hot, for when the passages to the House of Commons were lighted the architect insisted upon the pipes being placed four or five inches from the wall for fear of fire. And the curious often applied their gloved hands to the pipes to ascertain their temperature."

We note regarding the pamphlet we have been referring to that it has no paternity. No one seems willing at this late day to father it, and so it had to be brought out anonymously. And we do not wonder at it, for where it is not untruthful it is simply a rehash of stale and antiquated statements, and of opinions based on them, that have since been retracted, and which never went to the core of the matter anyhow.

The real question of to-day is not whether carbonic oxide is a poisonous gas, for this no one denies, but whether water gas, containing 20 to 25 per cent. of it, and less of other dangerous and deadly gases of which coal gas is largely composed, is, when used with the same precautions and under like conditions, any more objectionable than coal gas, particularly if from water gas there can be obtained a brighter light at less cost?

We have had considerable experience in introducing water gas into various cities and towns, and find that the first opposition from coal gas men comes in the form of the assertion that they can make coal gas as cheap as we can make water gas, and being beaten on this point in fair argument, they invariably fall back upon the bugbear, "carbonic oxide," as a last resort. This is the pretext, but the real objection often is either interest in gas coal mines or, for various reasons, interest in keeping a large force of men employed.

The "American Gaslight Journal" asserted, editorially, March 16, 1883, that there had been 100 deaths from water gas alone in New York City in the past five years.

We thoroughly investigated this, and found that there had been but 32 deaths in that time from accidental inhalation of all kinds of gas—an average of a little over six per year.

It is also asserted that "previous to the introduction of water gas in New York City, for 50 years there is no record of deaths from inhaling coal gas."

4 at ma-.

Now the Coroner's Records show 7 deaths from coal gas during the single year 1871, 6 years before water gas was introduced!

We place our works entirely on their merits, and we invite honorable criticism, but when the enemies of water gas are reduced to the use of misrepresentation and falsehood as weapons it shows how weak is their cause.

If gas were furnished for breathing purposes all this objection would be in order, and not more so with water gas than with coal gas, but as the gas is for illuminating purposes we think we have completely proven that when used with the least spark of intelligence, which is necessary with either gas, it is quite as safe as the coal gas with which most of our cities and towns have been lighted for years, and that, as a matter of fact, the only live questions are whether water gas will furnish a gas more brilliant than coal gas, and for less money, and to these questions we unhesitatingly answer in the affirmative, and only ask for opportunity to demonstrate it.

GUARANTEE.

To show the confidence we have in our improved water gas apparatus, we hereby offer to erect for any gas company complete works, at our own cost, under a rigid guarantee, and if it is not fully realized we will remove the works without costing the gas company one dollar.

We wish it to be most distinctly understood that we take all the risk, and we will be glad to give any further information.

A. O. GRANGER & CO.,

Engineers and Contractors, 22 and 24 N. Fourth St., Philadelphia, Pa.

APPENDIX E. PAPER 12.

AN OPEN LETTER TO THE AMERICAN (COAL) GAS LIGHT JOURNAL.

To the Editor of the American Gas Light Journal:

Your editorial, in issue of March 16th, headed "Carburetted Poison," was so manifestly one-sided, unfair and untruthful that we felt impelled to investigate its charges.

In the first place you refer to the publication in your paper, five years ago, of a series of articles "from the pen of Dr. Henry Morton, President of the Stevens' Institute of Tech-

nology, Hoboken, N. J., pointing out the exceedingly poisonous qualities of carbonic oxide, and the danger to public health that might result from permitting too large a proportion of this constituent in illuminating gas," evidently for the purpose of leaving the impression that it represents Dr. Morton's opinions today, and so using his great reputation to bolster up your war on water gas, which, as is well-known, proceeds from motives of self interest.

Now, let us ask why you did not publish Dr. Morton's later opinion found in the "Plumber and Sanitary Engineer" of December 8, 1879, in which he speaks of the danger of water gas as "small and modified by so many other conditions that this question undoubtedly would not influence its practical adoption for domestic use?" or his still later opinion of January 15, 1880, in the same valuable journal, where he expresses his belief that "it would be a question of economy and efficiency simply, whether water gas did or did not become the gas of the future?"

Is it not misleading? Is it not untruthful? Is it not dishonest, to publish an old opinion of a man who has since changed his views, without referring to his present opinion, though well known to you?

In the mind of any fair person such a misrepresentation would properly discredit anything your article contains.

Dr. Morton has repeatedly published his later opinions, as above shown, in order to correct the mischief done by his first articles in your paper, but, Bourbon like, you take no notice of them. Any mule can stubbornly stick to a position it has once taken, but it requires a strong, progressive man to change his published views, and so we honor Dr. Morton, whose later opinions coincide with those of some of the most eminent chemists of the world, viz: Dr. Adolphe Wurtz, Paris: Dr. E. Frankland, London; Dr. T. Sterry Hunt, Montreal; Dr. C. F. Chandler, New York; Dr. R. Ogden Doremus, New York; Dr. Gideon E. Moore, New York; Dr. Henry Wurtz, New York; Dr. E. G. Love, New York; Dr. Joseph Jones, New Orleans; Dr. W. H. Pike, Toronto; Dr. H. H. Croft, Toronto; as shown in our pamphlet on "Water Gas—Is it More Dangerous in actual use than Coal Gas?" Have you read it?

In the latter part of your editorial you assert that there have been 100 deaths from water gas in New York in five years.

Now, as a matter of fact, your list contains but 92 names, and these are divided into "deaths" and "suffocations,"* and from your own standpoint there were but 54 deaths.

Is it not maliciously false to magnify this number to 100 deaths? No one desiring to establish a character for veracity would be guilty of such wilful misrepresentation.

Now for the facts.

In a preliminary way we would remark that the courts have time and again decided that a journal publishing a libelous article, though copied from another source, assumes the responsibility of the charges.

You published a list in which it is made to appear, on the authority of the newspapers named, that the deaths and suffocations were caused by water gas. This is absolutely false, as not one of the papers states the kind of gas used on the premises.

What are we coming to, when a journal such as yours, purporting to represent a large commercial interest, so lightly publishes a statement injurious to another interest without first ascertaining the truth?

We have thoroughly investigated this list with a determination to get at the bottom facts. We confined our examination to New York City, and found in the Coroners' records 7 other cases not in your list which contains 7 Brooklyn cases, and so leaves the total number the same. We have examined the Board of Health records and the Coroners' records for the entire five years, and have visited the places where the deaths and suffocations were said to have occurred, and have examined the files of the papers given as authorities for the statements. We found it difficult to get accurate information, as many of the parties could not be found at all, no one of the name ever having lived at the place; in other cases the families had moved, and where we could find trace of the parties it was in most cases impossible to tell whether water gas or coal gas had been used, as in many of the streets we found pipes of three different companies, and the consumers were frequently changing from one to the other. A number of the "suffocated" ones had not even been insensible, and it was news to other "cases" that they had ever had any trouble with gas. Two of the cases were on Fall River steamers and caused by gas

* Suffocate means "to kill by stopping respiration" (Worcester). The word is evidently loosely used here to mean that the persons were rendered insensible and recovered.

from Fall River, where no water gas is made. In several cases we found that the persons had gone to bed drunk and, together with other cases of countrymen at hotels, had doubtless blown out the gas. One case was death from apoplexy and another from fractured skull—not even coal gas being responsible for these. Where deaths did occur (and we found them to have been caused by coal gas as well as water gas), they were chiefly at the lowest class of hotels and boarding houses, patronized by immigrants and the commonest and most ignorant class of people. The lack of ventilation in such quarters is well known, and to the people there fresh air in a bedroom is an unknown luxury; in such cases the result of stupidly blowing out the gas on retiring is certain death, no matter what kind of gas is used.

It is the list of deaths that we are mainly concerned about, and as shown above it dwindles at a glance from your assertion of 100 to 54.

Of this number we found 5 alive and well—that leaves 49.

But the coroners' record covering the five years' period of the list gives the deaths as 10 less than this, bringing it to 39.

And of this number 7 were suicides (the parties stopping up keyholes and even unscrewing the gas-brackets), so this brings the number of deaths from accidental inhalation of illuminating gas of all kinds to 32, instead of 100, from water gas alone, as you asserted.

As this number covers a period of five years the average is a little over six deaths per year.

Is there in this a sufficient basis of truth to warrant your bigoted opposition to water gas?

Is there in this a call for a new column in the Board of Health records, "Killed by water gas?"

You assert in the most positive manner that "previous to the introduction of water gas in New York City for fifty years there is no record of deaths from inhaling coal gas."

A statement with less of truth in it was never before published.

The coroner's record of New York City shows that in the single year 1871, six years before the introduction of water gas, there were seven deaths from accidental inhalation of coal gas.

Are all the editorials in your journal as near the truth as this one on "Carburetted Poison?" We presume that your reports of coal gas light conventions and the clippings taken from journals of known good character may be accepted as reliable, but here-

after your readers will be compelled to exercise their own judgment as to editorial matter, particularly when it relates to water gas. And to save them trouble we suggest that you add a new column to your paper, headed "Brand New Lies about Water Gas."

If you are actuated solely by disinterested motives of watchfulness over the public health and welfare, why don't you vigorously take up the cudgels against "coal oil," which causes many times more deaths than water gas or all kinds of gas combined?

Here is a field worthy of your prowess and in which you can obtain plenty of facts without being compelled to draw upon the imagination for arguments.

Why is it that we hear more of deaths from gas now-a-days? Simply because of opposition. When coal gas had an absolute monopoly of the business the causes of death were hushed up, just as when a railroad accident occurred the company tried to keep it out of the papers. But now that there are opposition companies we hear more of deaths from gas and railroad accidents than ever before, because the opponents take care to have the facts (and often more than the facts) published.

Even had there been of late years any increase in the number of deaths from illuminating gas, we might look for the cause in the immensely greater volume of gas used now, and this in turn caused by increased population and decreased price of gas.

The growth of immigration has been beyond precedent, and, as shown above, it is among this ignorant class that a large proportion of the accidents occur.

Calmly considered, the wonder is, not that there has been an average of six to seven deaths per year from inhaling illuminating gas, but that in a population of nearly a million and a half using nearly 20,000,000 cubic feet of gas daily, a very much greater number have not died from this cause.

In cases of murder or attempt to kill coming before our courts, inquiry is always made to find a motive for the crime. On looking for a motive for your repeated attempts to kill water gas (which has thriven wonderfully since you began your attacks), we find that you are owned by coal gas people and represent solely coal gas interests, and that the rapid growth of the cheaper and more brilliant water gas will bring your usefulness to an end for sheer lack of coal gas subscribers.

But the tide of water gas has set in and you cannot stay it. We welcome honest criticism but we detest falsehood and misrepresentation, and when a journal of your standing descends to the use of such weapons it clearly shows the weakness of your cause.

A. O. GRANGER & CO.,

Engineers and Contractors.

PHILADELPHIA, April 20, 1883.

APPENDIX E. PAPER 13.

The Corporation Councils for 1878 being organized and in session, the proposals respecting the atomic or steam coal gas was introduced by the president of the Common Councils, Joseph L. Caven, Esq., and referred to the new Joint Council Committee on gas works, to consider, examine, and report thereon, to whom the following was communicated on the 1st of February, 1878 :

To the Members of the Joint Committee on Gas, of the Corporation of Philadelphia, to whom has been referred my communications to the Corporation respecting the atomic or steam coal process of gas manufacture.

GENTLEMEN : Contained in the pamphlets before you are my offer to the Corporation, also the communications between myself and the City Gas Trustees, Chief Engineer, Special Committee of Trusts, our meetings and results, during the months past, and numerous inquiries ; all my statements have been admitted, none denied ; hence the offer of the trustees to allow me to use their works "with my new method of manufacturing illuminating gas, provided it will be of no expense to the Trust ;" also stating that, without consent or authority of the corporation, the trustees could not so alter or change the works.

In communication to the trustees, on page 9, are given the only reason why I could not so alter or change the works at my own expense and introduce the improved process without proper authority to do so, and be repaid therefor. If requested to change the generating portion of the city works, or a suitable section thereof, I will do so without delay ; all depending on the action of the corporation.

If the improvements are arranged for, in part only, by reference to page 6 you will find that the saving to the city in the article of coal alone will be nearly, or about one million dollars per annum.

Also, as explained at page 9 and other places, by adopting a part only of the atomic injecting improvement, more than double the quantity of gas will be generated from each ton of coal than now generated from coal at more than double the price now paid per ton.

Again, at same and other pages, are shown and explained that by using the whole improvements mentioned, constituting steam coal gas, more than four times the quantity of gas of good quality can be manufactured per ton of coal, supplied at less than half the present prices; beside other great advantages by the new process.

As minutely described in the communications, it is shown that coal gas can be manufactured so abundantly cheap as to be supplied to the public at fifty cents per thousand feet, or less, beside returning a handsome revenue to the city, as all works should, if properly manufactured and conducted.

An additional consideration arises of furnishing another gas for heating purposes at twenty-five cents per thousand feet. Thus supplying as much illuminating gas for one dollar (2,000 feet) by the new process as now charged $4.30 by the present process, half a century old. And a new gas for domestic and other uses, bath and other rooms, &c., of four thousand feet for a dollar, which now cost $8.60 by the present old process.

Estimating the consumption of illuminating gas in Philadelphia at ten million feet per day, the saving of price to consumers by the new process would be over $15,000 per day, and every day, as to the quantity consumed. Also, if made and supplied for heating purposes a further saving, as compared with the use of coal, of more than $30,000 per day in addition, beside comfort, cleanliness, uses, safety from fires, &c.

I shall be pleased, gentlemen, to explain anything pertaining hereto to your honorable committee or any chemical or scientific party you may suggest or desire, that you may be enabled to report on and derive the vast benefits referred to your committee for action and report.

Yours very truly,

JAMES CRUTCHETT.

To the Philadelphia Joint Committee of Councils on Gas, in Session March 1, 1878.

Gentlemen: After my communication to you at your last meeting on the atomic gas business, and answering questions of your members, a communication from Dr. Cresson was read, the meeting adjourned on the subject to continue the consideration to-day, when Dr. Cresson and myself were desired to be present.

I have applied to the clerk of the committee to be allowed to take a copy of Dr. Cresson's communication, but was refused; informed that he had been told not to allow a copy to be taken, so I have only to go by a newspaper report of it (The Record), in which my new process of gas manufacture "is denounced as altogether impracticable from the large volume of carbonic oxide gases, expensive cost to remove, increase of nearly 100 per cent. for fuel, destruction of apparatus, and alluding to experiments of Saunders, Spence, and others as unsuited for the manufacture of illuminating gas."

I can allow for the doctor's feelings, having been long attached to coal gas manufacture, the old retort system and his good father before him, the loss of his easy situation with the coal gas company, the fine salary and, perhaps, hopes of re-engagement. But his denouncements of my improvements without seeing and examining them indicates a clouded mind, which I will endeavor to clear, if you will allow me, gentlemen, by information of the actions of others in the business, practically and unclouded, beside my own experience and statements; endorsed by gentlemen of the highest chemical ability and practice known here and in Europe, referring him and the honorable committee to published statements in reference to my new mode of gas manufacture; previous to which allow me to premise by stating that the atomic or steam coal gas is far less expensive and difficult to purify, requires much less fuel and destruction of apparatus than the manufacture of coal gas by the present old process, there being no retorts to wear and burn out, and by the arrangements as shown by the drawings, little wear and tear except to inside lining of furnace of plain fire bricks, cheap and easily replaced when needed. I beg, also, to ask that other persons' inventions and failures be not confounded with the atomic or steam coal gas, the subject before your honorable committee.

The elementary gases, as distinct bodies, have been known only of comparatively recent date, oxygen by Priestly and others

since, many of their compounds not known as to how they assimilate and what they form at different proportions, temperature, &c., so that what was recently considered fatal and poisonous gases, have been found to be actually beneficial and active sustainers of life, some of which might be poison in states and small quantities before combustion or absorption become changed by the operation of uses.

Thus we know that there are poisonous and intoxicating elements in the composition of apples, peaches, grapes, and other fruits and vegetables, yet we should not be forbid using them as food and properly provided, because some enthusiast says there is poison and spirits in them. The same enthusiastic theory would denounce the use of the seed, herbs and other products of the earth; even the different varieties of bread, fuel, articles in manufactories, all stoves, fire places, steam boilers—even air and water itself would be denounced, because one has an excess of oxygen, hydrogen, carbon, power or combination not considered safe or healthy to those who use them.

In coal gas itself, made by the old retorts, I could quote particulars of some twenty kinds of poisonous and disagreeable gases I explained in a publication over thirty years ago; the same are found in them now, with a slight difference only as to the system in purifying.

The well-known chemist, Professor Wurtz, in his official report on water or steam gas, in November, 1875, says: "I must finally sum up by expressing with emphasis the gratification with which I have recognized the solid progress that is made by this successful progress, in realizing what I have long awaited as a real step in the arts of civilization—the cheap manufacture of combustible gas from carbon and steam."

Also (treating of carbonic oxide): "So far as could be judged to any poisonous or morbific action of this gas upon men, the anticipated objections to water gas on this score would appear to have been much exaggerated. I was surprised to find among the men constantly exposed to the inhalation of the pure water gas itself no ill effects," &c. So of other makers of water gas in different places.

The Commissioners appointed by the city of Boston to see and carefully examine all the principal gas works in the United States and Europe, in summing up their report, after near two years' investigation, in speaking of water or steam gas, say: "These now in use offer, in our opinion, a fair prospect of suc-

cess, and should be carefully watched and studied, having in view the most scientific and economical.—Chas. F. Choate, John Felt Osgood, Edward S. Wood, October, 1876."

There are now more than twelve water or steam and oil gas works in operation in the United States, besides others in Canada and Europe, also numerous wood gas works for lighting cities, producing large amounts of carbonic oxide in Europe, and others of part wood and other material producing the same or similar gases. Numerous chemists of high attainments have for years seen the desirableness of utilizing water or steam for making gas for illumination and heat. I have been engaged in seeking it to best advantage for more than thirty years with my own works, operated and published articles thereon, and at last the process I call atomic or steam coal gas, being the mixture of coal dust with steam gas, as explained and patented.

The Gas Trustees say: "We want some one to erect works and give definite results of the atomic or steam coal gas;" also that "the Trusts cannot change or alter the present works without the corporation so direct." The gas company of Washington city also says: "We want some one else to start it and then know the results;" and similar, other places. Well, gentlemen, while I have been explaining to your gas trustees and your late and present corporation committees, some Northern persons have been erecting works and for some months operating with my improvements at Mount Vernon, N. Y., without openly corresponding with me. The same has been examined closely and tested chemically and thoroughly by those of high talent, and practical water gas operatives, who work and operate the Lowe process, and others.

One of the chemical and mechanical experts, well known by his scientific communications in the "American Gas and Chemical Gas Engineer," Doctor or Professor George S. Dwight, of New York, and Professor Gideon E. Moore, Ph.D., the latter in his report, dated Jersey City, January 22, 1878, as published in five full broad columns of the "Engineer and Mining Journal," gives the detailed results of his close examination of the gas and its products, gravities, combinations, heating and lighting power and qualities, at numerous times, &c., among which he says:

"The amount of carbonic oxide falls short of the theoretical proportions, while there is a corresponding excess of hydrogen." Then he gives the causes and variations from the high temperatures and mixtures of gases, described, "1st, its value as a substitute for other forms of gaseous or solid fuel, in the arts

and for domestic use; 2d, its application for illuminating purposes, either as a substitute for ordinary illuminating gas, or as a diluent for very rich coal gas."

Again, "The cost of the gas being from six to eight cents per thousand feet, including the coal dust." And, "It is safe to say that for domestic use the cost of the gas would be, at most, 50 per cent. of the cost of coal fires, and in the summer even less." According to Percy (who has seen the steam gas used in England several years), "One ton of coal, free from ash, will yield fity thousand cubic feet of gas. The superior freedom of this gas from sulphur is an extremely valuable property for illuminating purposes.

"The absurdity of claiming that a gas containing as much as 25 to 30 per cent. of carbonic oxide is necessarily dangerous will best be apparent from the consideration of the amounts contained in wood gas, a material largely used wherever the relative cost of wood and coal renders it advantageous." Here follows the different woods producing from 20 to 61 per cent. of carbonic oxide, as analyzed by Pettenkoffer and Reisig, and the number of cities and towns lighted by wood gas in Europe.

The objections to water gas in general, on account of its contents in carbonic oxide, are based on an entire misconception of the meaning of the reports of the eminent scientific men who were called to pronounce upon the question of its safety in France, which was unfavorable for the following reasons:

"The gas was not saturated with illuminating hydro-carbons, and was consequently inodorous; it was not of itself luminous, but was employed to heat to intense whiteness small cages of platinum, which were suspended in the flame and furnished the luminous body. Being inodorous, the escape of the gas could not have been detected; hence the dangers arising from accidental leakage were excessive."

If the steam gas be made luminous by coal dust, it then becomes odorous, and herein only lies the safety of coal gas anywhere. "Coal gas, $\frac{1}{10000}$ of which can be detected in air by its odor, coal gas, if inodorous, would in all respects be as dangerous for domestic use as pure carbonic oxide gas."

Professor Moore closes his elaborate report on gas made from steam and coal dust, the atomic or steam coal gas, as follows: "I have no hesitation in stating as my opinion that water gas, when properly carburetted, is in all respects as safe for household use as ordinary coal gas. I cannot better conclude my report than by stating my entire concurrence in the opinion of

the greatest living authority on chemical technology. 'Rudolf Wagner,' in his great work, 'Jahresbericht der Chemischen Technologie, 1874,' p. 991, who, after alluding to the lack of success of the previous attempts to introduce water gas, owing to imperfect apparatus, says:

"Nevertheless, water gas still appears to us to be the illuminating gas of the future."

Professor Dwight gives two columns in same journal, and dated N. Y., January 30th, among which he states to the editor the development of the interesting success and "very substantial improvement as novel in conception as its results are surprising, to utilize coal dust, because of its abundance and cheapness, the rapidity of the evolution of the gas is proportioned to the reduced size of the carbon particles."

It is gratifying to state that the operations of the apparatus erected at Mount Vernon, in New York, where experimental practice, extending over a period of several months, has substantiated that a pure water gas could be obtained by the expenditure of not over 2,240 pounds of coal for each 50,000 cubic feet. It is found that this weight of fuel, including the quantity used under the boiler, is a perfectly safe estimate for a reasonably large scale of operations, while it has been done on considerably less: the proportions are one to three of lump and dust, and the labor necessary to produce half a million cubic feet for twenty-four hours would be three men on the shift.

On the above improvements, the editor of the "Journal" says: "Assuredly it is one of the most important that has come for many years before the public," &c.

Gentlemen of the committee, I have selected but little of the reports above alluded to containing proofs of what I presented to your honorable Corporation last May, and which lay near six months unconsidered by the gas trustees, and now before you. It further proves and shows that the gas consumers of this city are paying from four to eight hundred per cent. more for gas, for heat and light, than they might be supplied at with atomic gas, as I have heretofore particularly explained, thus causing a loss of from ten thousand to fifteen thousand dollars per day to the gas consumers. The amount of one-half of a day's loss would pay to erect a substantial working section of generating works to demonstrate the facts to the most obtuse observer.

Please allow me to say that everything I have stated in my communications are as represented as to great benefits and improvements spoken of, and when properly carried out by my arrangement of apparatus I now show you the drawings of, will

be even more beneficial than stated of the atomic or steam coal gas improvement, which I patented several years ago, but could not attend to for the reasons already given.

I might refer to one more confirmatory benefit elucidated.

The President of the Municipal Gas Light Company of New York recently requested the celebrated chemist, Professor Wurtz, to give his opinion as to the danger of water gas as compared with coal gas as generally made. The practical chemist explains and shows at length, in a long column of close print, "that coal gas contains the toxical constituents, so much so as to be much more dangerous than the carbonic oxide of water gas;" also "that the water gas carburetted and consumed in a room, giving the same amount of light as coal gas, would be nearly as two to one more healthy than coal gas." He gives the chemical causes and reasons therefor, January 1, 1878.

What great scientists and persevering industry of years past expected of the future as to the wonderful elements of water, if made of use, has now been fully demonstrated and brought to our doors for numerous uses and blessings. The gases made therefrom so easily, which, combined with refuse coal dust, is made into fine illuminating gas and also gas for heat as fuel, at the low prices mentioned, by the atomic steam coal process, as explained.

From these communications it will be seen that good illuminating gas, by this new process, will cost less than fifteen cents. per thousand feet for fuel, labor, wear and tear. Also gas for heating purposes for about ten cents. per thousand feet; this from the price of coal in Philadelphia, New York, and the seaboard cities; other places less or more, as to coal prices, &c. By proper works and management (leaving out political manipulation), gas can be supplied for lighting at fifty cents. per thousand feet, and for heating at twenty-five cents. per thousand feet, pay interest on the stock value, pay off three per cent. of principal yearly, keep all pipes and proper works in order, and have a large surplus revenue for charities and erection of public buildings, and similar in other cities, towns and establishments.

In conclusion, gentlemen, having devoted several months' time to induce your honorable corporation to let the public be benefited by this atomic or steam coal gas improvement, and your boards now meeting at more lengthened periods, I respectfully suggest that some action be taken by your honorable board, so that I may be engaged more effectually.

With respect, gentlemen, your humble servant,

JAMES CRUTCHETT.

PHILADELPHIA, PA., March 1, 1878.

Arrangements are now ready to be made to supply cities and places, free of royalty or patent right, where gas will be sold at the before-mentioned rates, and support a charity out of the surplus revenue as proposed to Philadelphia, or low rates to those who charge more in proportion.

If the government erect their own works, the consideration of which is now before Congress, to supply the public buildings, &c., in Washington, the inventor will arrange to supply the illuminating gas at 25 cents. per thousand feet, and heating gas at 20 cents per thousand feet, and keep all the works in good condition.

APPENDIX E.- PAPER 14.

REPORT OF JOINT COMMITTEES ON FINANCE AND LIGHT.

[Presented by Mr. Glasgow.]

To the Council of the City of Richmond:

The Joint Committees on Finance and Light, to whom was referred a resolution from your body of August 14, 1882, accompanied by a proposal of the United Gas Improvement Company of Philadelphia to supply the city with gas on certain conditions, beg leave to report:

On consideration of the matter it was referred to a sub-committee, consisting of two members from each of the two joint committees, to which was added their chairman. At a subsequent meeting, the sub-committee reported that they could not obtain such information as would enable them to make a satisfactory report on the quality of water gas, which it was proposed to supply, without visiting places where it is manufactured and consumed; thereupon the joint committees instructed them to make such visit and obtain full information. The sub-committee having discharged this duty, presented a report to a subsequent meeting, signed by four of its members—viz., Messrs. Glasgow, Cohen, Todd and Barksdale—giving the results of their investigations, the substance of which will be embodied in this report. A minority report was also presented, signed by one member, Mr. Higgins. This will no doubt come before you in a minority report from the two joint committees.

The sub-committee say in their report:

In pursuance of your instructions, we visited several of the northern cities seeking the information desired. The discussion of the subject at home had developed apprehensions of the quality of what is known as water gas, and that its use was deleterious, and to this feature we addressed our inquiries as well as to its illuminating power and merits generally; and as we found that water-gas was made by various processes and under various patents, it may be well to state that in all it is made by the use of water converted into steam, the hydrogen being obtained by decomposing the steam, and the illuminating power added by the use of petroleum oil or some one of its products; that is, it is made from water and oil by different modes of manipulation, the product being the same in all, its illuminating power varying with the quantity of oil used.

We first visited in New York the works of the Excelsior Gas Light Company, at Astoria, and spent several hours with the president, Mr. Gross, and the treasurer, Mr. Perry. We found the small gas works formerly used for coal gas now used as an experimental station to prove and perfect the process invented by Mr. Gross.

Mr. Gross claims that his process is perfected. He exhibited to us the works in operation, and the gas seemed to us satisfactory in all respects. He had recently contracted to light the town of Astoria, and had commenced digging for the mains.

We next visited the Municipal Gas Company. This company was organized to supply water gas within the past few years. The secretary stated, in proof of the merits of their gas, that their production had already grown to a daily output of 4,000,000 cubic feet. He referred us to the New York Hotel, where we were lodged. Our inquiries at the hotel proved that the gas was in all respects satisfactory, and our own observations confirmed it.

We next visited the Manhattan Gas Company and had an interview with the secretary and engineer. This is the largest gas company and one of the oldest in the city, and supplies coal gas only. The officers of this company treated us very courteously, and answered our inquiries frankly.

The question naturally suggested was, why, when it was claimed that water gas was superior both in quality and economy, they still adhered to coal gas? Their answer was substantially to deny that water gas was of better quality than theirs, and as to any difference in cost, they had never been satisfied that it was sufficient to justify the large loss they

would sustain of three-quarters of a million of dollars in making the change, besides the large sum demanded for the right to use the water gas; that their conclusion was, at present prices they were doing well, and it was wisest to let well enough alone. In answer to a further inquiry, they said they were bound to admit that, as far as they knew, water gas gave satisfaction to its consumers.

We had now visited the two largest gas companies in the city—one coal and the other water—but neither having experience in the process of the other. We next concluded to visit the New York Gas Light Company, an old company which had previously furnished coal gas, but in 1880 bought the water gas privilege at a cost, we were told, of $300,000, and since then have supplied their customers with water gas. We found the secretary in his office, and learned from him that his company is satisfied they did well to make the change; that certainly the cost of water gas was found to be less than coal gas, and that it gave his customers better satisfaction. He assured us that there was nothing in the manufacture, distribution or use of it, that caused any doubt of the propriety of the change.

The sub-committee visited, amongst others, the Brush and Edison Electric Light Companies, and obtained information of the progress made in introducing the incandescent light in private houses. They witnessed an illustration of it in the Everett House, where the electric light had been substituted for gas in the chandeliers formerly used for gas. The secretary of the company (the Edison) did not claim that the electric light could be made at as low cost as gas, but that from its superior merits it would gradually supplant it. He stated also that he was using water gas in his residence, and that there was no ground for any charge that it was inferior in any respect to coal gas.

In Philadelphia we found the gas works owned by the city, and the gas furnished on municipal account. A bitter contest was going on between a committee of one hundred selected by the people and the trustees of the gas works. We found a wide-spread dissatisfaction with the management. It was denounced as a corrupt political ring that had for years controlled all elections in the city, and enriched its members out of the public treasury. The result was that the people had become so disgusted that there was a general clamor for the sale of the works.

Our informant, a very intelligent lawyer and a native Virginian, though a pronounced Democrat, had been elected to the City Council from a strong Republican district on this issue; had been appointed a member of the committee of one hundred, and had taken an active part in the contest. He told us that whilst nine-tenths of the committee favored a sale of the works, he differed from them, however, and thought the city's wisest policy was to retain the ownership of its works, and after ousting the present management to let out the manufacture of the gas, delivered in the holder, to private enterprise, the city to take charge of the distribution, and to stand between the contractor and the citizen. In this mode the evils of political influence would disappear, and the gas be obtained cheaper than when manafactured on municipal account. He told us further that though the committee had been gradually winning for a year or more, the people electing its nominees, yet so strongly were the managers entrenched that it would require a year or more still to finally dislodge them.

In Baltimore we found the Consolidated Gas Company supplying both water and coal gas, and we obtained here quite as satisfactory information as we had gotten at any other place. The president of this company, which supplies much the largest part of the gas consumed in the city, stated that they had formerly used coal only. Some five or six years ago they adopted the water process for about one-fourth or one-third of their capacity; after using it for two years, and finding it necessary to increase their capacity, they decided to enlarge their water gas works, and they are now making about equal quantities of each. In one district they distribute water gas separately, and in another they distribute it mixed with coal gas. In every respect—in manufacture, distribution and consumption—the water gas had given satisfaction, and when mixed with coal gas had improved its quality. In cost they found it from five to ten cents per 1,000 feet less; it may be remarked that they manufactured coal gas very cheaply. Mr. Hall, the president, thought the policy of his company should be to maintain their works for the manufacture of both, because in this way they could to some extent influence the prices of coal and oil.

In Washington a coal gas company hitherto had recently contracted with Messrs. Granger & Co. for the erection of water gas works of some 600,000 feet capacity. The company have also recently erected coal gas works upon a process patented by their engineer. Both works were in operation in the same building.

We heard no objection to the quality of the water gas; on the contrary, it was admitted to have greater illuminating power than the coal gas. Mr. McIlhenny, the company's engineer, is said to be well educated in his profession, and as great effort has been made to use his name against the Granger process, it seems proper to inquire what his testimony is, and whether he is a proper judge to give a verdict between his own invention and the other. Being a competent engineer, he examined into the merits of the water gas before introducing it. If there had been any ground for the charge that it is dangerous or deleterious, would he have permitted its introduction, or would he now be distributing 15,000,000 feet of it monthly in the city of Washington, where the highest standard and most rigorous test is enforced? Nor does he make any such charge. Mr. McIlhenny has induced his company to erect at large cost works on his patented plan and on his representation of its merits. His reputation is at stake to prove the justice of his claims. Is he the impartial judge who is to decide upon the merits of the Granger process? Whatever his character and his merits, no court in the land would accept him for a moment as a juror in such an issue.

To sum up, in all our investigations we found no one familiar with the manufacture or consumption of it to call in question the good quality of water gas. On the contrary, the large preponderance of evidence was in favor of its superior quality and cheaper cost. Against a very bitter opposition from the coal gas interest, it is rapidly winning its way to public favor. To-day, though of comparatively recent introduction, nearly one-half the gas consumed in the city of New York is water gas, and quite one-half in the city of Baltimore, and there, where millions of feet are daily distributed, not one word did we hear against its quality. It is, therefore, our opinion, that if favorable terms are offered for its introduction, there should be no apprehension as to its quality.

The sub-committee presented a proposal from the Excelsior Gaslight Company, which they thought contained the basis of a favorable contract for the city. They recommended that if the details could be arranged satisfactorily, that this proposal be accepted, whereupon it was referred to them for further consideration. The two joint committees met on the 19th instant. The sub-committee reported that they had not been able to arrange satisfactory terms with the Excelsior Company, and had abandoned the negotiation with them. They presented a pro-

posal from Messrs. A. O. Granger & Co., which was recommended for acceptance by a vote of 4 to 1. Plans and specifications were also presented from the Committee on Light, with a resolution appropriating $25,000 for the purpose of remodelling a part of the retort-benches. After a discussion of the relative merits of the two propositions, upon a vote a majority of the committees favored the offer of Messrs. Granger & Co., and recommended it for your acceptance.

It seems proper that this report should give the reasons that influenced the majority in their decision. The minority will present to you a report, and will doubtless fully state the reasons for their action.

Some months ago the auditor prepared a statement showing the cost of gas for a period of five years prior to the 1st of February, 1882. The cost was distributed under three heads —labor, coal and expenses. This statement also showed the net annual production of gas during the same period furnished by the superintendent of the gas works. The result shows the cost of gas during that period $1.35\frac{1}{2}$ per thousand feet. He has now brought this statement up to January 1, 1883, and the result is not materially altered. No one calls in question the accuracy of this statement. The auditor's books show the money to have been paid, and the reckoning is made on the statement of product furnished by the superintendent of the works. During the past year it began to dawn on us that our gas was costing too much. A proposition from the United Gas Improvement Company stimulated this belief, and set on foot an inquiry which has resulted in the two reports now before you. Let us examine the majority report: Messrs. Granger & Co. are engineers and builders of water gas works. They have constructed a number of gas works in different parts of the country, converting coal gas works into water gas works, and furnish evidence that their work and their process has given satisfaction. Unobjectionable evidence was obtained in Philadelphia of their commercial standing and responsibility.

They propose to erect works at their own cost, with a capacity of 700,000 feet per day (50 per cent. greater than ours), and to furnish gas of eighteen-candle power in the holder at 60c. per 1,000, the city to have the option of buying the works at the end of the first year for $50,000, and at the end of each succeeding year for $5,000 less, until at the end of the eleventh year the works, with the rights, revert to the city.

The minority report presents a resolution appropriating $25,000 for remodelling one-half the benches in the retort-

house upon a plan submitted by Mr. Anderson, of Cincinnati. It was suggested to the chairman of the Committee on Light, that Mr. Anderson should accompany his plan with a bid for the construction of the work; that there would not occur hereafter, should the city adopt his plan, such an opportunity for competition, and that it was obviously his interest now to make his bid as inviting as possible. After the city adopted his plan there would seem no alternative but to give him the work, as we must hold the author of the plan responsible for its success. The reply of Mr. Anderson was that he would let us know the cost after the city adopted his plan; and this seems to have satisfied the chairman of the Committee on Light. We will learn then what the work will cost after the city is committed to the plan.

Let us consider now what it is claimed will be saved under the Anderson plan. He claims that the labor will be reduced by the discharge of twenty-eight men in the retort-house—this and no more—a saving of 16 cents per thousand feet. He claims that the coal will cost 38½ cents, and the auditor shows it now costs 46 cents—a saving of 7½ cents. These two items make 23½ cents saved by his own figures, and this is all. The auditor's statement referred to above shows that the only other item entering into the cost of gas besides labor and coal is for incidental expenses. These, we may infer, consist of lime and other materials for purifying, repairs, small tools and implements, materials for smith-shop, office charges, and numerous small items, for which the city has paid during the past five years 11 cents per thousand feet of gas manufactured.

There is no other saving but the two items named above.

Now the problem stands thus:

	Per M.	
Present cost of gas shown by the auditor........	$1 35½	
Deduct (per Mr. Anderson's statement) for residuum	11	
Leaving cost..........................		$1 24½
	Per M.	
Mr. Anderson claims saving of twenty-eight men.	16	
Saving on coal..............................	7½	
		23½
Cost by his claim at burner, per thousand..		$1 01
Deduct for distribution:		
Mr. Adams shows cost of it......		12
Cost by Mr. Anderson's claims in holder, per 1,000.		89

Compare the above with the results on Messrs. Granger & Co.'s proposition:

	Cts.	
Contract price in holder	60	
Add for condensation	6	
Cost in holder		66
Add for distribution as above		12
Per thousand		78

In the above the only uncertain elements are Mr. Anderson's claims, that with the new benches of retorts twenty men will do the labor of forty-eight, and that he will obtain from the coal $16\frac{2}{3}$ per cent. more gas than is now obtained—that is, if one pound of coal yields now $4\frac{1}{2}$ feet of gas, in the new benches it will yield 5 4-10 feet. Both these claims are largely too great.

Mr. Anderson presents the following estimate of cost:

Coal	$38\frac{1}{2}$ per 1,000.	
Purifying	5	
Labor	17	
		$60\frac{1}{2}$
Less residuum		11
		$49\frac{1}{2}$c. in holder.

	Cts.
The Auditor shows the present cost of labor, per 1,000	78
Deduct distribution per Mr. Adams	12
Leaving cost in holder	66
Deduct for 28 men discharged	16
And the cost of labor remaining is	50

Mr. Anderson solves that problem and derives the result of 17 cents.

The Auditor shows cost of incidental expenses	11
Mr. Adams allows for purifying	5
Leaving out of his estimate	6

These figures show how false are the results obtained from a partial standpoint, but there is a defect in his estimate pointed out by Mr. Adams, which shows how deceptive it is even from his own standpoint.

In that estimate the month of December or the present is assumed as the basis. In the winter time, the production being so greatly increased, the cost per 1,000 is greatly diminished. Fortunately it can be shown what the gas would cost for the entire year on the estimate presented of 49½ cents, based on the cost in December.

The Auditor shows the cost for the entire year		$1 35½
Deduct for distribution	12	
Claimed for residuum	11	
	—	23
Present cost in holder		$1 12½
A published statement gives cost in December in holder 66c.,		
Add for condensation, 6½c.		72½
Difference in cost in December and the entire year		40
Add the estimate presented of		49½
Cost in holder for the entire year		89½

This result is derived from the data offered us, and shows beyond question how deceptive is the estimate given of 49½ cents in the holder.

It has been shown that, giving Mr. Anderson credit for all he claims, the gas will cost in the holder	89
By Messrs. Granger & Co.'s bid, which is absolute and not estimated, the gas will cost in the holder	66
Showing in favor of Granger	23

The Superintendent estimates the year's production at not less than 120,000,000 feet net. On this the saving in one year is 27,600; add to this the appropriation for remodeling the works, $25,000, and the city is the loser in one year to the extent of $52,600.

It is by no means admitted that there would be saved 23½ cents on the present cost, as is claimed under the Anderson plan. There is the same quantity of coal to be handled and carbonized, the retorts and furnaces, being enlarged, which is the only change. It seems a very rose-colored view that by this change twenty men would then have only the amount of labor to perform that forty-eight men do now.

Our estimate would divide this claim by two, granting a saving of fourteen men, 8 cents. In Mr. Anderson's letter of 22d

December last he estimates the increased yield of gas from the coal at 5 to 10 per cent.; grant a saving of 7 per cent. on the cost of coal, which is 46—3 cents—makes the saving on the Anderson plan over present cost, by our estimate, 11 cents; making 34 cents difference in favor of Granger, equal to an annual saving to the city on 120,000,000 feet of $40,800.

Referring to the proposal of the United Gas Improvement Company, the committee express the opinion that it is not the true policy of the city to part with the ownership of its works. The policy they recommend is to let out the manufacture of gas delivered in the holder, which it has been shown can be done at greatly less cost than to continue the present process—the city to take charge of the distribution, and stand between the contractor and the citizen. In other respects the offer now presented to you is much more favorable than that of the United Gas Improvement Company.

For the reasons set forth above, and because they believe a better gas will be furnished under it than under the Anderson plan, and at greatly reduced cost, the two joint committees have instructed me to recommend for your acceptance the proposal of Messrs. A. O. Granger & Co., which is herewith presented.

Respectfully submitted,

F. T. GLASGOW, *Chairman.*

PROPOSITION OF GRANGER & CO.

PHILADELPHIA, January 5, 1883.

F. T. GLASGOW, Esq., *Chairman, &c., Richmond, Va.:*

DEAR SIR: We hereby offer to erect at our own cost at your City Gas House, in building to be furnished by you, complete Lowe gas works of a guaranteed capacity of seven hundred thousand cubic feet per day, and to manufacture and deliver into your holders gas of not less than eighteen-candle power, for the sum of 60c. per 1,000 cubic feet—you to furnish purifiers and station-meter, and we to have entire charge of the gas works, and to furnish all material and labor.

The contract for furnishing gas at these rates to be for eleven years, and we give the city the right to purchase the works and exclusive patent rights for the city of Richmond, under the Lowe patents, and including our improvements, at any time—

During the 1st year for	....	$55,000 00
Or at end of 1st year for	....	50,000 00
" " 2d "	....	45,000 00
" " 3d "	....	40,000 00
" " 4th "	....	35,000 00
" " 5th "	....	30,000 00
" " 6th "	....	25,000 00
" " 7th "	....	20,000 00
" " 8th "	....	15,000 00
" " 9th "	....	10,000 00
" " 10th "	....	5,000 00
" " 11th "	....	0,C01 00

We can erect the works without disturbing your present coal gas plant, and we can be ready to make gas in four months from date of contract. We are ready to give bonds in $25,000 for the faithful performance of the contract.

The city is to have an option of 60 days as to the acceptance of above.

Respectfully, &c.,

A. O. GRANGER & CO.

MINORITY REPORT—PRESENTED BY MR. TAYLOR.

RICHMOND, January 24, 1883.

To the Hon. President and Members of the Board of Aldermen:

GENTLEMEN: The undersigned regret very much that they are compelled to dissent from the recommendation of the majority of the committee that a contract be made with Mr. Granger, of Philadelphia, to furnish gas to the city for a term of years at 60 cents per thousand cubic feet. This we feel constrained to do—

First. Because it is against the well established policy of the city to surrender full and complete control of our water and gas, a policy which the experience of other cities has taught us is a wise one, for wherever municipal corporations have parted with the control of the manufacture of gas they have almost invariably found cause to regret it.

Second. We object to the lease to Mr. Granger because it is not so favorable as another plan that has been suggested. If the Council will adopt the resolution appropriating $25,000 to make certain needed improvements at the works the running expenses of the department will be greatly lessened, and the

cost of manufacturing gas, delivered at the holder, can be reduced to fifty cents per thousand cubic feet, which is 10 cents cheaper than the price which it is proposed to pay Mr. Granger. It is estimated that we will manufacture during the next fiscal year 135,000,000 feet of gas, for which under the proposed lease we would pay Mr. Granger $13,500 a year more than it cost us to make it; and as it is proposed to make the lease for ten years, we would in that time pay him $135,000 of the people's money, which we might save if we made the gas ourselves. This is assuming that there will be no increase in the amount of gas manufactured; but as with the growth of our population there will most certainly come an increased demand for gas, it is not unreasonable to assume that we would, by making our own gas, save in the next ten years not less than $175,000—enough to make a handsome nucleus for the building of the much needed City Hall.

That your honorable body may know that our estimate of the proposed cost of manufacturing gas by the city is not an over sanguine one, we herewith submit the estimates, from which it will be seen that we have understated rather than over-estimated our ability to make gas at less cost to the city than is proposed by the contract with Mr. Granger.

Trusting that this report may have your favorable consideration and approval, we are, very respectfully yours,

John M. Higgins,	W. R. Bowie,
John H. Frischkorn,	W. S. Gunn,
James E. Phillips,	Richard M. Taylor.

Superintendent's Office,
City Gas Works, January 20, 1883.

Mr. John M. Higgins, Chairman Committee on Light:

Dear Sir: Below please find a statement of the cost per 1,000 cubic feet of making gas in the holder under the plans submitted by Mr. Anderson:

Amount of gas generated in 24 hours.......600,000 cubic feet.

Amount of coal required, 59 tons, at $3.85....	$227 15
Labor in retort-house, 20 men at $2.25.......	45 00
Labor on coke-stand, 5 men, at $2.25.........	11 25
Labor in purifying-room, 3 men, at $2.25.....	6 75
Labor in engine-room, 2 men, at $2.43........	4 86
Labor in smith-shop, 2 men, at $2.50 and $1.50.	4 00
Labor at lime-kiln, 2 men, at $2.............	4 00

Labor at bricklaying, 1 man, $2.70	2 70
Labor at weighing coal, 1 man, at $2.25	2 25
Labor at repairs, 1 man, at $2.43	2 43
Labor in yard, 3 men, at $2	6 00
1 day foreman	3 75
1 night foreman	2 43
Incidental expenses	48 00
Total	$370 57

	Cts.
Cost of labor per 1,000 cubic feet	16
Cost of coal per 1,000 cubic feet	37
Incidental expenses	8
	61
Credit by residuals	11.5
Total	49.5

Very respectfully,

JOHN H. KNOWLES, *Superintendent.*

APPENDIX E. PAPER 15.

A REPORT IN FAVOR OF MAKING COAL GAS UNDER MUNICIPAL CONTROL.

RICHMOND, VA., February 5, 1883.

To the Council of the City of Richmond:

The undersigned, a minority of the Joint Committee on Finance and Light, would respectfully submit the following report, for which they ask the earnest consideration of the members of both branches of the City Council.

The majority of the committee in their report to the Board of Aldermen ask to establish two points. First: That it has been successfully established by gas companies in New York, Baltimore and Philadelphia that water gas can be made of as great purity and far less money than coal gas. Second: That it would be wiser for the city to let out the manufacture of gas, delivered in the holder, to private enterprise, the city to take charge of the distribution, and to stand between the contractor and the citizen. In this mode they claim that the evil of political influence would disappear, and the gas be obtained cheaper than when manufactured on municipal account.

First, then, has the committee in their report successfully established the fact that water gas is of as pure a quality as that made from coal? Who are their witnesses? Let us see. We are told that the sub-committee that went North first visited the works of the Excelsior Gaslight Company at Astoria, and spent several hours with the president, Mr. Gross, who afterwards at their request came to Richmond, and so enthusiastic were the majority of the committee that his process was the best they had seen, that they actually recommended that a contract be made with him to furnish gas for our city. But, when Mr. Gross was required to give $25,000 security for the faithful performance of his contract, his company suddenly discovered that, after all, his process was not so good as they had at first supposed, at least they could not afford to risk any money on it.

The next visit was made to the Municipal Gas Company of New York, and the report tells us that the secretary made statements to show the merits of his gas. In this, however, there is a slight error. It was not the secretary whom we met. We met the vice-president, who introduced us to Mr. Stern, who gave us the information alluded to, and he is not the secretary of the company, but was the original promoter of water gas in New York and controls the patents now in use by that company. We would hardly regard him as a disinterested witness.

In Baltimore the committee called upon the officers of the Consolidated Gas Company, who, according to the report, only claim that water gas can be made for "from five to ten cents per thousand feet less" than coal gas; and as oil is much dearer now than it was then, it is fair to infer that as oil advances, its cost of manufacture soon becomes as great or greater than gas manufactured from coal.

When the committee reached Washington they were met at the depot by Mr. Granger, who had very courteously provided a carriage to take them to inspect the works recently erected by his firm for the gas company in that city. The committee have sought to impair the value of the testimony of Mr. McIlhenny, a distinguished gas engineer of Washington, and who strongly favors the manufacture of gas by coal, because he is an inventor of processes for making coal gas. We do not see why Mr. McIlhenny should have been dragged into this controversy. He has not obtruded his views upon any one. The committee called upon him at his works in Washington, and like the courteous gentleman that he is, he very cordially answered such questions as the committee asked him. He has never intimated that he desired to make a bid for the manufacture of our

gas, nor do we know that he would ever consent to do so if invited. Why then was his name mentioned? It was because it was known that he had stated to a member of the committee that coal gas was the best that could be made, and that if the new retorts asked for by the Committee on Light were built, that gas could be manufactured by the city at a much lower figure than has yet been offered by the Granger or other water gas companies.

But who is Mr. McIlhenny, and what is the value of his testimony? We will let Mr. Granger himself answer the question. At a recent meeting of the sub-committee, Mr. Granger being present, he was asked if he knew Mr. McIlhenny, and was requested to give his opinion of him as a man and as an engineer. He replied that he knew Mr. McIlhenny very well; that any statement that he might make on any subject could be regarded as entirely trustworthy, and that as a gas engineer he was recognized as at the head of his profession in the United States. The value of Mr. McIlhenny's testimony explains then why the majority of the committee should seek to break the force of it.

Second, we desire to say something in reference to the proposition to let out the manufacture of gas to some outside party. We must confess that we were not a little astonished at the manner in which this phase of the question is discussed. What has the mismanagement of the trustees of the Philadelphia Gas Works to do with this subject? What has the "corrupt political ring that has for years controlled all elections" in Philadelphia, and enriched its members out of the public treasury, to do with this question?

The following members of the Council constituted the Committee on Light the past four years:

Capt. John A. Curtis, *Chairman*; Dr. William H. Scott, L. Wagner, C. R. Barksdale, W. S. Gunn, J. E. Phillips, W. J. Gentry, L. D. Grenshaw, Jr., J. H. Goddin, Dr. O. F. Manson, Thomas Potts.

Is it intended to imply that the above gentlemen have been a "corrupt political ring," who have sought to control all "elections in this city?" If no such reflection was intended, then why was any such allusion so foreign to the question introduced into their report? If there has been any such corrupt political influence at work, why has not the attention of the Council been sooner directed to it? Why wait until the question of cheap gas is discussed? Was it to excite prejudice against longer municipal control of the gas works?

The gentlemen who signed that report know that any implication of corruption or dishonesty in the present or past management of the works would be as outrageously false as it would be unjust, and we would fain believe that it was not so intended by them.

The majority does not submit any argument to establish their proposition, but are content with a simple declaration "that the evil of political influence would disappear" if gas was furnished the city by contract. But, in fact, is there not more danger to be feared from the presence of a wealthy corporation, having valuable franchises, seeking to influence our elections by corrupt means, than there is that political harm will result from the city's control of its own gas department.

In conclusion we will say—First, that for information concerning the deleterious quality of the water gas, we refer you to the accompanying list of fatal and serious accidents resulting from the inhalation of illuminating water gas in New York and Brooklyn, from 1878 to 1882, and accompanying reports. Second, that as to our ability, with the new retorts, to furnish coal gas at less cost than the Granger system, we need only to say that independent estimates, based upon the present high prices of coal and labor, have been made by Supt. Knowles, Mr. McIlhenny, the distinguished Gas Engineer of Washington, and Gen'l Hickenlooper, President of the Cincinnati Gas Company, all of whom agree that if the new retorts asked for be furnished we can manufacture our own gas at less cost than it can be furnished by contract with any outside company. Third, we will only say in conclusion that we earnestly hope that it may be the pleasure of the Council to adopt the following resolution, believing that if it is done it will be the happiest solution of this much vexed gas question:

Resolved, The Board of Aldermen concurring, that the sum of $25,000, or so much thereof as may be necessary, be placed to the credit of the Committee on Light, to be used for the remodeling of the works; the said $25,000 to be raised by the issue of bonds, or in such other manner as the Committee on Finance may deem best.

JOHN M. HIGGINS,
W. R. BOWIE,
JAMES E. PHILLIPS,
W. S. GUNN,
RICHARD M. TAYLOR.

MINORITY REPORTS OF JOHN M. HIGGINS.

TO JOINT COMMITTEES ON FINANCE AND LIGHT.

RICHMOND, VA., November 17, 1882.

Members of the Joint Committees of Finance and Light:

GENTLEMEN: With all due respect to the opinions of the intelligent gentlemen of the sub-committee and our expert, Col. Cutshaw, I beg leave to offer as a substitute to the seeming plausible report presented by them, a minority one, that I think, without being egotistical, will demonstrate most conclusively that the process recommended by them is the one above all others to be least considered, as it is only the outcome of the mind of a visionary enthusiast. The Magnus Gross process is both unknown to and untried by the leading gas men of this country. In evidence, the secretary of the Manhattan Works did not know of such a process until his engineer informed him that he had visited Astoria, and found that the Gross process possessed no merit and was not worthy of consideration.

Recognizing the importance of our mission, in considering the various propositions, affecting as they do one of the chief departments of our city, valued at one and a quarter million of dollars, and in which the whole people are interested, I, as the representative of that department, felt that great indeed were the labors to be involved, and as this department was the only one to be affected, that a chief of that department should have accompanied us, in order that we might have had the benefit of his knowledge in considering the various systems; but other counsel prevailed, and the interest of the department had to be represented in the committee and a part of the tour of inspection by only your humble servant. Leaving the city under the impression that in conjunction with our immediate mission an inspection of the leading gas works of the cities to be visited was to have been made, whereby we might be the better able to compare the different systems and arrive at more comprehensive opinions than we have been able to do from the limited field of our observations, and knowing what a great fund of valuable information might be gained by pursuing this course, I endeavored to impress upon the minds of the other gentlemen of the committee the importance of this step, but they thought otherwise, and, as I did not wish to make a personal visit, I had to abandon it. In Philadelphia we were received with marked

courtesy by Mr. Page, a member of the City Council and chairman on Light, who spoke of the importance of visiting the Gas Works, where much would be learned and the practical operations of the works could be inspected, and voluntarily tendered our chairman a letter of introduction to the manager of the works. Here, also, the opportunity presented itself from whence we might have gained much, but I am sorry to say it was not availed of.

Gentlemen, with the limited ability at my command I have endeavored faithfully to note and observe these various systems, and shall, as far as lies in my power, give to you in plain and accurate language the statements made by the representatives of the different works, and the conclusions that I have arrived at in going over the field of our labors.

NEW YORK.

On the morning after our arrival in New York, a Mr. Perry, a reported wealthy importer of that city, called on us at the hotel, as arranged with our chairman by a merchant of this city. Mr. Perry is a representative of the Excelsior Gaslight Company. From the conversation we had with him at the hotel I learned that the gas furnished by the Consolidated Company of Baltimore was a failure on account of the great difficulty in cleaning the gas and the process being very expensive.

Mr. Perry also represented that there is great complaint against the gas furnished by the Municipal Company of New York on account of its smoky character, which Mr. Magnus Gross confirmed, with the additional statement that the system in use by that company is a cumbersome, complicated operation, and continually making changes at the works, which must be very expensive.

In company with Mr. Perry we visited the Excelsior Gas Works at Astoria. Mr. Gross explained this process. [Consists generally in bringing together in a retort heated to 1700° or 1800° Fahrenheit the vapors of naphtha and of superheated steam. By this perfect mixture of the vapors of naphtha and water a mutual decomposition takes place and the resultant gas, composed of olefiant gas, marsh gas, carbonic oxide and free hydrogen, needs no purification or further treatment beyond passing it through the condenser to precipitate any excess of watery vapor uncombined with constituents of the gas.]

The works are only experimental. Not a foot of gas has been sold by that company there. Mr. Gross admitted that he had great trouble with his works; had to change his process several times; had his retorts charged four months, and claims that he

can work them for one year without opening them. The capacity of the holder is about five thousand feet. I noticed a good deal of tar dripping from one of the retorts. Mr. Gross may be, and I presume is, a good chemist; but I claim that he is not well versed in the manufacture of gas, and from a practical standpoint his system will never meet with the approval of experienced gas men.

Called on Mr. Strong, of the American Gas, Fuel and Light Company, who informed us that the Gross system is very expensive on account of the quantity of oil to be used in the manufacture of gas, which would make the cost under this system greater than coal. Mr. Strong stated that with his process he could make gas at about forty cents per thousand. The cost to remodel our works would be about $35,000.

Visited the office of the Municipal Gas Works. Met the vice-president of the company, who introduced us to Mr. Stern, who controls the patents now in use by that company. Mr. Stern told us that he would sell the patents for $50,000, under which we could make gas at about fifty-seven and a half cents per thousand, and he claims that twelve-candle-gas by his process is better than twenty-candle coal gas. Could not speak of the great merit of his process at present, as he had just finished experiments, which would be complete in a few days, by filling three cupolas with the substances, which will last indefinitely. Can make it with a forty-five-candle gas without using one atom of coal, and no trace of sulphur to be found in the product. On the whole globe there is no such gas as that made and furnished by the Municipal Company. The gas made by other concerns is trash gas. The Lowe process is an absolute failure; can't make a uniform gas. This company owns the right to its use; would be glad to dispose of it at one-quarter the cost. As it has never been used by the company, would not undertake to have our works remodeled. Have two friends who could make the changes. One of them he could recommend with safety. The vice-president of the Municipal Company informed me that if we went to Rochester expecting to find the Municipal Gaslight Company a success, we would be very much disappointed.

Called at the office of the Manhattan Gas Company. Met Mr. Smith, the secretary, and the engineer. The former stated that they had such confidence in their (the coal) system, that they proposed letting well enough alone. Their product is entirely satisfactory to their customers, and the best evidence of it is to be found in the increasing demands made on them

for gas. Do not fear electricity nor the new process for making gas. Have made money by not purchasing new inventions and various patents that have been offered to us. It is not our custom to abuse or find fault with other companies, although some of them are jealous of us. The Municipal Company claims to make good gas, and we presume that they do. The price charged in this city for gas is $2.25 per thousand.

PHILADELPHIA.

Called on Mr. Page, a member of the Council and Chairman on Light. He prefers coal gas to the water gas. Informed us that the latter process had been abandoned in Paris and London, and referred us to a report of the Boston Commission on that subject; advised us against the sale of our works. Gave the chairman a letter of introduction to Mr. Wood, who was in a position to give us valuable information.

Mr. Wood received us very kindly. He expressed his regret that his brother Walter was not in, as he was the person who could give us the information. In a few minutes Walter made his appearance, and when informed of the proposition made by the United Gas Improvement Company simply remarked that we were in dangerous hands.

Mr. Granger, at his office, explained his system of making gas, and emphatically denied that the Gas Improvement Company have the right to use the Lowe patent in Richmond.

NORRISTOWN.

Visited Norristown, Pa., in company with Messrs. Elkins, Stewart, Bodine, and Poindexter. At the request of Mr. Gibbs, we did not go to Norristown until the day appointed by him, to enable their consulting engineer, Mr. Lowe, to have everything ready for our inspection at their works. I departed for Norristown expecting to see the best managed gas works in America, and great indeed was my surprise and disappointment when we were ushered into a machine shop, where Professor Lowe explained his mode of making gas-stoves and other machinery. From the shop we were conducted to the Professor's office and study-hall; after that, cooking with a gas-stove was fully explained, which was neither new nor novel to me. I did not see a gas house nor a foot of gas manufactured by the Professor. He only explained his method of making gas as being superior to the systems now in use in Baltimore and Washington, which is not a success under the old Lowe process. The new process, he claims, is far ahead of the old.

BALTIMORE.

A member of our committee made arrangements with Mr. Hambleton, the engineer of the Consolidated Gas Companies in Baltimore, to meet us at the hotel. He was there according to appointment, but refused to see us save professionally, which was declined by the committee. The conduct of Mr. Hambleton was a disappointment to me, for from what I heard of him as an experienced gas engineer, I expected to be able to obtain some valuable information as to the various modes of making gas.

Mr. Cohen succeeded in obtaining an interview for us with the gentlemanly vice-president of the company, Mr. Graham, who received us most cordially, and upon being informed of the object of our mission promptly stated that he is in favor of the coal gas, or the old system, but would and did introduce us to Mr. Hall, the president of the company, who very kindly explained the results of both methods, showing only a difference of about five to ten cents a thousand in favor of the water gas at the present price (four and a half cents) paid by the company for oil. Price paid for coal, \$3.85 per ton.

Yield of coal	5–19 cubic feet.
Retort yield	6,000 " "
Per cent. of cannel coal	2 per cent.
Candle power of coal gas	19
Candle power of oil gas	21.25
Retorts in present use	216

WASHINGTON, D. C.

As arranged with Mr. Granger, and at his request, he furnishing transportation from hotel to the gas works and back, we visited the Washington Gas Works for the purpose of inspecting the works recently erected there by him. Mr. Granger introduced us to Mr. McIlhenny, the engineer of the works, with a request that he would give us the working results of his process. Mr. McIlhenny very frankly stated that the results are not all satisfactory, nor coming up to the guarantee, which was about 700,000 feet, and the make amounted to about 400,000, or a little over half; but that Mr. Granger is doing all in his power to make good his agreement, but he has failed so far.

On account of the large amount of coke on hand, and with no demand or market for it, in order to utilize the coke, Mr. Bartol, the president, was led to believe that it could be used in the manufacture of water gas; but after a trial of the coke it was

found to be entirely too light for the furnace, and had to abandon the coke and use anthracite coal, which with it and the present price—six and one-third cents. charged for oil—makes this system dearer than coal gas.

Mr. McIlhenny informed us that he was charging the Government only $1.50 per thousand, and all other consumers $1.75 per thousand, and that the quality of the gas had to come up to the standard adopted by the Government, who had a special inspector to test it every day at the office established by the Government for that purpose. Mr. McIlhenny remarked that it appeared strange to him that he was selling coal gas at a much less price than the parties who are making water gas, when they claim that it can be made at about forty cents a thousand and are charging $2 and upwards; appeared to him as extortion. Mr. McIlhenny spoke in complimentary terms of the management of the Richmond works, and the results appeared favorable for old works.

Before separating, Mr. Granger spoke of Professor Lowe and his party in terms not complimentary, and especially of the Professor, whom he would not believe upon oath, for the reason that he contracted with a party to execute some work, for which he received $3,000 in advance on account, and after pocketing the money refused to comply with his contract. When a suit was instituted against him to enforce the terms of the contract and recover the money, it was proven in court that the professor and consulting engineer of the United Gas Improvement Company was not worth the value of one dollar in his own name. Mr. Granger related several transactions of the professor of a similar character.

Gentlemen, I propose to show from the testimony of experts and facts gathered from the press that this process, if adopted, will be far more expensive than coal gas. In evidence, Mr. Strong says that the Gross process could never compete with coal gas on account of the fluctuations in the oil market and the large amount of oil that would be required in the manufacture of gas under this process. Extracts from northern papers will give you an idea of the rapid increase of the price of oil, due to the limited supply; in fact, the supply is now less than the demand. How is it possible, gentlemen, that at this late day innovators, speculators and adventurers hope to blind people with the idea that gas made under their various processes is cheaper than coal gas, when their chief exponent—oil—is advancing in price and its supply diminishing, while on the other hand we

have inexhaustible supplies of coal, at cheap rates, at our very doors? Even now new and extensive mines are being opened in southwestern Virginia on the Tennessee line.

I read from the Philadelphia *Record*, November 1st; *Press* of that city, November 7th, 1882; and New York *Sun*, November 5th, 1882, the rapid advance in petroleum:

[From the Philadelphia Record,]

BRADFORD, PA., October 31.

The steady and rapid decrease of oil production is shown in clear and startling figures by the monthly report of operations, to be printed in the *Era* to-morrow. There has been no such marked decrease during the space of one month for many years, and from the figures of October, 1881, one year ago, there is shown a decline of fully 75 per cent. Compared with last month there is a falling off of fifty completed wells and over 2,000 barrels new production.

One hundred and eighteen wells were completed in October throughout all the oil regions. The production of these wells on October 31, was 1,865 barrels, or an average of less than 16 barrels per well. This average production of these wells will be reduced within thirty days to about 8 barrels. During the month 21 "dry holes" have been drilled—10 more than in September. These fruitless ventures represent a loss of not less than $150,000.

New work during October shows 156 rigs up, a decline of 28 from September, and 148 wells drilling, an increase of 24 over September. This increase of wells drilling is owing to the consumption of operations in the Allegheny field. When the Cherry Grove excitement sprung up, scores of rigs in Allegheny that were ready to start drilling were shut down, and these are now being rapidly finished. The bulk of operations, indeed, is in the fields over the State line. With the utmost possible activity, however, they are unable to keep up the production.

The once famous Cherry Grove section, which three months ago produced 50,000 barrels daily, is now shrunk to contemptible proportions, clearly defined, and almost deserted. The original Mystery well on Lot 546 is pumping barely 20 barrels daily. Hundreds of once prolific "gushers" have stopped entirely, and the entire production of the district is now less than 5,000 barrels daily.

From the best sources the entire production of the various fields may be thus estimated:

Bradford	37,000	barrels
Allegheny	12,000	"
Cherry Grove	4,500	"
Outside regions	9,000	"
Total	62,500	

The amount of crude required daily is not less than 70,000 barrels. The deficiency of over 700 barrels daily must be drawn from the stock held in tanks by the pipe lines, about thirty million barrels in all. Of this amount fully two-thirds is used for purposes of speculation.

[From the New York Sun.]

NEW YORK, November 5, 1882.

The Petroleum Exchanges in this city, Bradford, and Oil City were excited yesterday over the rapid advance in the price of crude petroleum. Only a few weeks ago petroleum sold as low as 50 cents per barrel. Yesterday it sold at \$1.20 per barrel. The most lively advance was on Friday and yesterday. In the Petroleum Exchange in this city the price of oil opened at 94c. on Friday morning. At noon it sold at 98c., and closed at \$1.04½ per barrel. It opened yesterday at \$1.17½, sold up to 1.20, and closed at \$1.19½. The sales for the day in the three Exchanges mentioned were over 18,000,000 barrels. Only once before, on September 18th last, have the total transactions been as large. On that day they aggregated over 22,000,000 barrels. The cause of the advance is a falling off in production, which has been both natural and artificial. Last summer the production was considerably over 100,000 barrels per day. It has fallen off so that now it is only about 60,000 barrels per day. The Cherry Grove district, which used to yield 35,000 barrels per day, now yields only about 4,000 barrels. It is asserted that natural decrease in production has been aided by a bull pool, of which the Standard Oil Company is the head, and that, at the instance of the pool, producers have been induced to stop drilling, and that the Standard Oil Company has stopped pumping with its pipe line, and is letting the oil from the wells run upon the ground.

[From the Philadelphia Press.]

PHILADELPHIA, November 7, 1882.

Oil jumped from \$1.26⅝ to \$1.36 in fifteen minutes yesterday morning, and for an hour after the latter quotation went up on

the bulletin board, the Oil Exchange on Walnut street, near Third, was a howling bear garden. Saturday's market closed at \$1.20, but so intense was the excitement among the Bradfordites that buying and selling went on without any intermission throughout Sunday, prices ranging from \$1.26 to \$1.30. Yesterday the market opened at \$1.25, touching \$1.22 at 1.15, and for the rest of the day vibrated in the most unprecedented fashion, most of the time hovering in the thirties, and closed at \$1.25 at Oil City, \$1.25½ at Bradford and \$1.24 at Pittsburg. The rise to \$1.36 came at 10.45, and was an advance of ten cents on the preceding quotation. No such jump in so short a space of time has been seen for three years, and it was not surprising that the bulls, who have been predicting \$1.50 oil before the close of the year, went wild at the prospect. The largest holders continued buying all they could get their hands on, and reports from the oil region stated that many who had sold early in the day turned buyers under the prospect of a still further advance. Immense sums of money are flowing into the oil region under the stimulus which the market has received during the last four or five days. The influx to Bradford alone is estimated at \$20,000,000.

The remarkable character of yesterday's fluctuations is emphasized by the variations in the refined market. Rarely does it respond to the temporary vibrations in crude, but yesterday there was a perceptible upward movement. The London refined market, which was at 7⅜ Saturday, stood at 7⅝ yesterday. In Antwerp there was an advance from 19¼ to 20½, and in Philadelphia and New York there was the same upward tendency. Yesterday's sales of crude in this city were between 100,000 and 125,000 barrels to 200,000 on Saturday.

EXCITEMENT IN THE STATE.

[Special dispatch to the Press.]

PITTSBURG, November 6.

If it was possible for the excitement at the Pittsburg Oil Exchange to be greater than it was on Saturday, then to-day it must have reached the pinnacle of speculative frenzy. For fifteen minutes before the bell rang for the opening this morning premonitory growlings gave notice of what was coming. The lobby was packed with eager curiosity mongers and "pikers," and it became necessary to get a police officer to keep a path open for the members and others having business in the Exchange. As the time drew near for the commencement of operations the brokers struggled on to the railing, and stood there

with expectant eyes fixed on the clerk, awaiting till the gong should sound and send them off on the wild race toward the goal of $2 oil. At the first tap brother Vandergaft managed to get in a solo, "I'll give $1.25 for fifty old," but the next minute he was only one in a chorus of some fifty voices singing their willingness to buy or sell at all rates between $1.20 and $1.30. Several thousand barrels were sold at the opening figure, $1.25, and then the price dropped to $1.23¼, but quickly rallied and climbed by steady gradations to $1.29. The bulls then put their powerful neck under the market and with a bellow of triumph hoisted it to $1.39, the highest point reached during the morning session. It afterwards dropped to $1.32, closing at $1.29½, at which figure the market closed. During the day the enormous total of 11,367,000 barrels changed hands.

TITUSVILLE, November 6.

The excitement in oil circles still continues. The market to-day reached $1.36½, the highest point it has reached within six years. It then broke to the closing point at $1.25. Oil was offered to-night on the street in large blocks at $1.22¼. The great feature in to-day's transactions have been weak buyers and heavy sellers. Titusville capitalists will realize about $2,000,000 by this advance. The advance is probably checked for a few days, but it will end in an upward tendency. Refined oil advanced to 9 cents., but fell off at closing to 8⅝ cents. The transactions to-day amounted to over 1,000,000 barrels.

BRADFORD, November 6.

The excitement on the Oil Exchange to-day, as was anticipated, was greater even than on Friday and Saturday, the opening being at $1.30, which was followed by a sharp decline to $1.23, and a subsequent appreciation to $1.34. From this on there was a general and stubborn decline to $1.25½, at which the market closed. The sales were enormous in all the exchanges, those of Bradford, Oil City and Pittsburg aggregating 39,235,000 barrels, more than double the amount ever sold before in a single day.

POISONOUS QUALITY OF WATER GAS.

As to the poisonous quality of water gas, I submit the opinion of Charles U. Sheppard, Jr.:

LABORATORY FOR ANALYTICAL CHEMISTRY,
20 Broad Street (Up stairs).
CHARLESTON. S. C., July 24, 1880.

Major HENRY E. YOUNG, *Charleston, S. C.:*

In compliance with your request, I beg leave to submit herewith my objections to water gas.

It is dangerous.

According to the analysis, by their own chemist, of the commercial water gas manufactured according to the "Tessie du Motay" process by the Municipal Gaslight Company of New York city, it contains about 28 per cent. of carbonic oxide gas (*a*).

The amount of carbonic oxide in the ordinary coal gas may be stated at about 6 per cent. (*b*)

In fact, the principal difference—from a hygienic standpoint—between the two gases lies in the larger content of carbonic oxide in water gas and of marsh gas, or light carburetted hydrogen, in coal gas. In the treatment of the intensely heated carbonaceous matter with steam, it is the object of the manufacturer of water gas to produce as much as possible of carbonic oxide—a combustible gas—to the end of diminishing the quantity of carbonic acid gas, which is incombustible. There is no feasible method of subsequently removing the carbonic oxide from the gaseous product, desirable as this step is regarded by all.

"Carbonic oxide gas is not only unfit for respiration, but it is deleterious. Not only can it suffocate, it poisons." (*c*)

"One hundredth part of this gas (carbonic oxide) mixed with pure air, renders it almost paralyzing for warm blooded animals." (*d*)

"Carbonic acid is a gas of so poisonous a character that, according to Leblanc, one volume of it diffused through one hundred volumes of air totally unfits it to sustain life." (*e*)

"Warm blooded animals soon die in an atmosphere containing carbonic oxide, even a slight admixture, as low as one per centum being sufficient" (to produce that effect). (*f*)

The small content of carbonic oxide in coal gas imparts to it its poisonous properties, since the more abundant constituents (hydrogen and marsh gases) are simply irrespirable—*i. e.*, non-life sustaining—but are not poisonous, and the authorities seem agreed in estimating the deleterious effects of coal gas by its

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(*a*) Report of Prof. Henry Wurtz to Charles D. Francklyn, President of the Municipal Gaslight Company of New York, March 4, 1878; Journal of Gaslight, Weter Supply, &c., May 7, 1878.

(*b*) Chemistry, hiorganic and organic, Bloxam, p. 141, Encyclopedia of Chemistry. vol. i., p. 994. American Gaslight Journal, March 2 and 16, 1878.

(*c*) Traite Elementaire Chemie Medicale, Ad. Wurtz, vol. i., p. 239.

(*d*) Chemie appliquee a la Phyzioligie, a la Pytholigie, et a l'Hygiene, Gautier, vol. i., p. 14.

(*e*) Chemistry, hiorganic and organic, Bloxam, p. 118,

(*f*) Lehrbuch der Experimentellen Toxicologie, Herman, p. 102.

percentage of carbonic oxide.(*g*) But as water gas contains four to five times as much carbonic oxide as coal gas, it is not strange that numerous deaths have resulted from the substitution of the former for the latter, or that the use of an illuminating gas possessed of such deadly properties has been expressly forbidden in countries where the preservation of the citizen's life is a matter of serious governmental concern. (*h*)

The unignited escape of water gas for a few hours from an open burner of the ordinary size, into a close sleeping apartment of common dimensions, would introduce sufficient carbonic oxide to jeopard, if not destroy, human life, since (as before quoted) the contents of the poisonous gas has only to reach 1 per cent. to prove deadly to an unconscious sleeper.

Again, the products of the combustion of water gas are more deleterious than those of coal gas. When equal volumes of both are burnt, water gas produces about fifty per centum more carbonic acid gas. (*i*) Consequently, with the same consumption of water gas and coal gas the atmosphere of an apartment would be much sooner vitiated by the use of water gas.

Perhaps the most terrible calamities arising from the inhalation of illuminating gas occur in houses into which the service-pipes have not been introduced, but into which the gas finds its way through drains or other openings from a defective main, and where the true cause of the trouble is at first passed over owing to the non-consumption of gas on the premises. (*j*) That under such circumstances the consequences would be much more serious with water gas than with coal gas follows very naturally from my previous remarks on carbonic oxide. In fact widespread disorders which were at first regarded as epidemics of cerebro-spinal meningitis and typhoid fever have been traced to the presence of carbonic oxide in the atmosphere. (*k*)

[Signed] CHAS. U. SHEPPARD, Jr.

(*g*) Handbuch der gurichtilchen Chemie, Sonneuschein, p. 299, Handbuch derToxikologie, Huseman, p. 657. Lehrbuch der practischen Toxicologie, Werber, p. 82.

(*h*) Report of M. Pelouze to Municipal Council of Paris, June 24 and 28, 1854. Journal of Gaslighting, &c., May 28, 1878. American Gaslight Journal, June 16, 1880.

(*i*) "Carbonic Oxide," Prof. Henry Morton, American Gaslight Journal, March 2 and 16, 1878.

(*j*) Gewerbe Hygiene, Eulenberg, p. 352 ; Beziehungen der Luft zu Cleidung, Wohnung und Boden von Pettenkoffer, p. 87.

(*k*) Gewerbe Hygiene, Eulenberg, p. 602.

PERSONS INJURED BY INHALING WATER GAS.

I now come to the verification of Mr. Sheppard's predictions, with a list of fatal and serious accidents resulting from the inhalation of illuminating water gas in New York and the city of Brooklyn, from 1878 to 1882:

[For list of names see page 93.]

THE ACTIONS AND OPINIONS OF THOSE INSTRUMENTAL IN INTRODUCING WATER GAS INTO THE CITY OF NEW YORK, REGARDING ITS DANGER.

The manufacturers of water gas, seeing the fatal results from its use, began in 1881 to attempt the removal of the poisonous carbonic oxide, as evinced by extracts from the following letter of Civil Engineer John F. Harrison to E. Stern, Esq., original promoter of water gas in New York city, and controller of the patents now in use by the Municipal Gas Company:

New York, September 8, 1882.

E. Stern, Esq.: According to an arrangement made with you in January last, that in conjunction with M. Jerxmanowski, I should conduct an experiment at the works of the Municipal Gas Company on Forty-first street, near Eleventh avenue, for the purpose of determining the practicability of manufacturing gas for illuminating and other uses by the decomposition of steam in the presence of quick-lime and thereby getting rid of the noxious element of carbonic oxide so abundant in the ordinary process of water gas manufacture, by transferring it into carbonic acid while in the nascent state, to be subsequently removed by proper appliances, I will state that from May 10 to June 5, both inclusive, we made fifty-seven experiments, and thereby ascertained all the essential features of the problem that could be attained. * * *

Respectfully submitted,

JOHN F. HARRISON.

In conclusion, from the evidence that I have been able to gather, I have been unable to be possessed of one fact that would show to my mind the feasibility of such a plan. In the first place, I am of the same opinion of Mr. Smith, secretary of the Manhattan Works, as regards all these processes, and especially experimental ones, believing in letting well enough alone, and saving money to the city by letting all adventurers and ex-

perimentalists pass on. How is it possible, gentlemen, for us to recommend a process that has no merits of its own, only those claimed by its inventors? The committee visited Astoria, the headquarters of the Gross process, and I think they saw no great proofs there that would warrant the adoption of such a system. What proofs could be gathered from experimental works?

Whenever you adopt this system, or others of a similar nature, you destroy one of the poor's greatest resources—their purchase of coke—which will entail much suffering and cause of complaint.

Gentlemen, over two hundred thousand bushels of coke was in the main purchased last year, by a class of people unable to pay six dollars for a load of coal, but who could manage to pay two dollars for a load of gas-house coke!

Other and more cogent reasons could be given, only for the limited time I had at my disposal since our adjournment on Wednesday night last, but I think I can confidently say that I have produced sufficient proof that would warrant every member coming to the same conclusion I have, viz.: That in the Magnus Gross process we see nothing that would induce us to adopt such a process, or to give up our works for the benefit of an experimenter.

Respectfully submitted,

JOHN M. HIGGINS,

Member of Sub-Committee.

RICHMOND, VA., December 7, 1882.

To the Joint Committees on Finance and Light:

GENTLEMEN: I very much regret the necessity which constrains me to differ with my colleagues of the sub-committee, but duty alike to the city and myself compels me to protest against the adoption of their recommendation that Mr. Perry and his associates be allowed to experiment at our works with the Magnus Gross process. I have endeavored to give this question a most searching examination, and to that end have examined the statistics of 566 gas companies of this country (a list of which is hereto appended.) This I did for the purpose of determining how far the adoption of the various new processes for making gas had resulted in lowering the price of that article. The information, I confess, has suprised even me.

Four hundred and forty-six of these companies make what is known as "coal gas;" two of them furnish gas to consumers as

low as $1.00 per thousand cubic feet, and eight of them charge as high as $5.00 per one thousand cubic feet. The average price of the four hundred and forty-six companies is $2.78 per thousand feet. There are one hundred and twenty companies making gas by various patent processes; the lowest price charged consumers by any of these processes is $1.25 per thousand cubic feet, whilst five of them charge as much as $10 per thousand cubic feet, and the average price of the 120 patent process companies is $3.75½ per thousand cubic feet.

It thus appears that both the lowest price by any single company and the lowest average by all the companies is in favor of those making coal gas.

Mr. Magnus Gross, in his circular letter of September 1, 1882, states he can deliver gas to the holder at a cost of fifty cents per thousand. But remember, gentlemen, that this estimate was based upon the then price of oil, which at that time cost three and one-half or four cents a gallon, but has since been as high as seven or eight cents. As the oil, or naphtha, is one of the leading articles used in the manufacture of gas, it would appear that the changes in the cost of manufacturing this article must in its very nature be violent and fluctuating.

As to the danger attached to making gas from oil, I do not intend to enlarge upon, as it must be clear to the minds of all. For corroboration I refer to the terrible explosion in the Standard Oil Company's yards, Brooklyn, a few days since, when two tanks containing eleven hundred barrels of oil exploded, causing the death of two men, and destroying property to the amount of $41,500.

If the process of Mr. Gross is so very meritorious why is it that he has never succeeded in satisfying any of the gas companies of its practical utility? They are ready and do pay what seem to us fabulous prices for the use of valuable patents. Why, then, has Mr. Gross never succeeded in doing anything with them? It must be because his scheme, to their minds at least, appears utterly visionary.

From the above facts I am forced to conclude that the best thing we can do is to continue the manufacture of coal gas, adopting, however, such improvements as are employed by other companies, adding such material as will improve the illuminating quality of our gas, and doing whatever else is necessary to secure a better and cheaper article.

But for the agitation of the question of the sale of our works, the Committee on Light, if aided by the Council, would by this time have been ready for making a purer gas at a greatly reduced

price—and this we will yet do if allowed the opportunity. We felt it was a courtesy due this Joint Committee not to attempt anything in this direction as long as the question had been referred to you for your recommendation.

In conclusion, I beg leave to respectfully protest against the Magnus Gross process.

Yours very respectfully,

JOHN M. HIGGINS,

Member Sub-Committee.

A LIST OF GAS COMPANIES IN THE UNITED STATES,

GIVING THE PROCESS OF MANUFACTURE, AND THE PRICE CHARGED PER THOUSAND CUBIC FEET.

ALABAMA.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
Huntsville	Coal	$3 50
Mobile	"	3 00
Montgomery	"	3 00
Selma	"	3 00
Talladega	Wood and Coal	5 00

ARKANSAS.

Hot Springs	Wood	4 00
Helena	Coal	4 00
Little Rock	"	3 75

CALIFORNIA.

Sacramento	Coal	3 50
Healdsburg	"	5 00
Los Angeles	"	4 50
Modesto	"	5 00
Placerville	Pine wood	10 00
Napa City	Coal	5 00
Oakland	" and Lowe Water	3 50
Oroville	Oil, coal and pine wood	5 50
Petaluma	Coal	4 00
Salinas City	"	5 00
Santa Cruz	"	4 70
San Francisco	"	3 00
San Jose	Lowe water and coal	3 50
San Louis Obispo	Coal	5 00
Santa Rosa	"	5 00
Stockton	"	3 50

COLORADO.

Colorado Springs	Coal	3 00
Denver	"	2 50
Georgetown	Hanlon oil	4 50
Leadville	Coal	4 25

CONNECTICUT.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
Danbury	Naphtha	$1 80
Birmingham	Coal	2 12½
Hartford	"	2 00
Meriden	"	2 77
Middletown	Lowe water	2 50
New Haven	Coal	2 25
New Britain	"	2 50
Norwalk	"	2 50
Norwich	"	3 00
Rockville	"	2 25
Stamford	"	2 50
Waterbury	"	2 00
Winsted	"	3 75
Willimantic	Hanlon oil	2 50

DELAWARE.

Dover	Coal	2 70
Milford	Lowe water	3 50
New Castle	Coal	3 00
Wilmington	"	1 50

DISTRICT OF COLUMBIA.

Georgetown	Coal	2 50
Washington	"	1 75

GEORGIA.

Athens	Coal	4 00
Augusta	"	3 00
Columbus	"	3 00
Macon	"	3 00
Savannah	"	3 15

INDIANA.

Vincennes	Coal	2 50
Columbus	"	3 00
Crawfordsville	"	3 50
Elkhart	"	3 50
Evansville	"	2 00
Ft. Wayne	"	2 50
Franklin	"	3 00
Goshen	Petroleum	3 00
Greensburg	Oil	3 50
Indianapolis	Coal	2 00
Jeffersonville	"	2 25
Kokomo	"	2 50
Lafayette	"	2 75
Laporte	"	3 00
Logansport	"	2 70

INDIANA—Continued.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
Madison	Coal	$2 75
Muncie	"	2 00
New Albany	"	2 50
Peru	"	2 00
Richmond	"	2 00
Rushville	Oil and naphtha	3 50
Seymour	Kutz's patent	2 00
Shelbyville	Coal and naphtha	3 50
South Bend	Coal	3 00
Terre Haute	"	2 50
Valparaiso	Oil	1 50
Warsaw	Kutz's patent	2 00
Washington	Coal	2 50

IOWA.

Burlington	Coal	3 00
Cedar Rapids	"	3 20
Clinton	"	3 50
Davenport	"	3 00
Fairfield	"	3 00
Independence	J. D. Patton's patent	2 50
Dubuque	Coal	3 50
Marshaltown	"	3 50
Mount Pleasant	"	3 50
Muscatine	"	4 00
Oskaloosa	Coal and oil	3 00
Ottumwa	Coal	3 50
Sioux City	"	3 50
Waterloo	J. D. Patton's patent	2 50

ILLINOIS.

Aurora	Coal	3 00
Belleville	"	2 50
Cairo	"	2 25
Carlinville	"	3 00
Centralia	"	3 25
Chicago	"	2 25
" "People's"	Coal and oil	2 50
" "Hyde Park"	Coal	3 00
Danville	"	2 60
Decatur	"	3 50
Dixon	J. D. Patton's patent	8 00
East St. Louis	Coal	3 50
Elgin	"	3 00
Evanston	"	3 00
Freeport	"	4 00
Galena	"	4 00
Galesburg	"	2 60
Jacksonville	"	3 50
Joliet	"	2 50
Kankakee	"	3 00

ILLINOIS—Continued.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
La Salle	Coal	$3 00
Macomb	J. D. Patton's patent	2 50
Mattoon	Coal	3 00
Mendota	"	2 50
Moline	"	3 50
Monmouth	"	3 00
Morris	Crude petroleum	10 00
Ottawa	Coal	3 00
Pekin	"	3 00
Peoria	"	2 25
Princeton	"	2 50
Pullman	Lowe water	2 25
Rockford	Coal	2 50
Springfield	"	2 50
Sterling	Lowe	2 80
Streator	Coal	3 00

KENTUCKY.

Bowling Green	Coal	3 00
Covington	"	2 50
Henderson	"	2 25
Lebanon	Oil	2 00
Lexington	Coal	3 00
Louisville	"	2 00
Mt. Sterling	"	3 50
Owensboro	Coal	4 00
Paris	"	3 50
Shelbyville	"	3 00

KANSAS.

Emporia	Coal	2 50
Ft. Scott	"	3 50
Lawrence	"	3 00
Leavenworth	"	3 00
Topeka	"	3 00

LOUISIANA.

New Orleans	Coal	2 00
New Orleans—Jefferson City	"	4 00
Shreveport	"	4 00

MAINE.

Augusta	Coal	3 50
Bath	"	3 50
Belfast	"	3 61
Brunswick	"	3 60
Calais	"	3 00
Ellsworth	"	2 50

MAINE—Continued.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
—Gardiner	Coal	$3 50
Hallowell	"	4 00
—Portland	"	2 50
Rockland	"	3 00
—Saco	"	3 00

MARYLAND.

—Annapolis	Coal	2 25
—Baltimore—Consolidated	Lowe and coal gas	1 90
Baltimore	Coal	1 00
—Cambridge	Oil	10 00
Cumberland	Coal	2 50
Easton	"	2 50
Frederick	"	2 00

MASSACHUSETTS.

Adams	Coal	2 70
Amherst	Naphtha	7 50
Arlington	Coal	3 25
—Athol	"	2 50
Attleboro	"	3 00
Beverly	"	3 50
—Boston	"	2 00
Boston—Charlestown	"	2 50
Boston—Roxbury	"	2 50
Brocton	"	2 75
Brookline	"	2 50
—Cambridge	"	2 50
—Chelsea	"	3 00
Clinton	"	2 75
Dedham	"	3 25
Dorchester	"	3 00
East Boston	"	2 50
—Fitchburg	"	2 50
—Great Barrington	Petroleum	3 50
Greenfield	Coal	3 50
Gloucester	"	2 50
—Haverhill	"	2 20
—Holyoke	"	2 25
Jamaica Plains	"	2 25
—Lawrence	"	1 05
Lexington	Hanlon's patent	6 00
—Lowell	Coal	1 65
Lynn	"	2 50
—Malden	"	3 00
Marblehead	"	3 75
Marlboro	"	3 00
Nantucket	"	3 00
—New Bedford	"	2 50
—Newburyport	"	2 70
—Newton	"	3 00

MASSACHUSETTS—Continued.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
North Adams	Coal	$2 70
Northampton	"	3 00
North Attleboro	"	3 00
Pittsfield	"	2 85
Quincy	"	4 00
Salem	"	2 50
South Boston	"	2 50
Southridge	Crude oil	4 00
Taunton	Coal	1 75
Wakefield	"	3 50
Waltham	"	2 70
Ware	"	3 25
Webster	"	4 00
Westfield	"	3 50
Woburn	"	2 60
Worcester	"	2 25

MICHIGAN.

Adrian	Coal	2 75
Coldwater	"	3 50
Detroit	"	2 25
Detroit—Mutual	Benzine and coal	2 00
East Saginaw	Coal	3 00
Flint	"	2 70
Grand Rapids	"	2 00
Hillsdale	"	3 50
Jackson	"	2 50
Kalamazoo	"	2 50
Lansing	"	2 84
Marshall	"	3 00
Monroe	"	3 25
Muskegon	"	3 00
Niles	"	3 50
Pontiac	"	2 50
Port Huron	"	2 50
Ypsilanti	"	3 00

MINNESOTA.

Faribautt	Naphtha	3 00
St. Paul	Coal	4 00

Min. capital,

MISSISSIPPI.

Columbus	Coal	3 50
Holy Springs	J. D. Kutz's patent	3 50
Jackson	Coal	5 00
Natchez	"	4 00
Vicksburg	"	4 00

MISSOURI.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
Carthage	Coal	$3 25
Columbia	"	3 00
Hannibal	"	3 00
Jefferson City	"	3 00
Joplin	"	3 25
Kansas City	"	2 50
St. Joseph	"	2 50
St. Louis	"	2 50
St. Louis—Power and Heat Company	"	2 50
St. Louis—Laclede Company	"	2 50
Sedalia	"	3 50

NEBRASKA.

Lincoln	Coal	3 60

NEVADA.

Carson City	Shale and pitch pine	6 00
Reno	Coal	6 00
Virginia City	Shale and pitch pine	6 50

NEW HAMPSHIRE.

Claremont	Oil	3 00
Concord	Coal	2 25
Dover	Hanlan's patent	2 70
Exeter	Coal	3 50
Keene	Lowe	3 50
Laconia	Crude oil	5 00
Manchester	Coal	2 00
Nashua	"	2 30
Portsmouth	"	2 76
Somersworth	"	3 30

NEW JERSEY.

Arlington	Smith & Goldthrop	4 00
Atlantic City	Petroleum and water gas	3 00
Bergen Point	Coal	3 00
Bordentown	"	2 80
Bridgeton	"	2 50
Burlington	"	2 00
Camden	"	2 00
Elizabeth	"	2 50
Englewood	"	4 00
Freehold	"	3 50
Gloucester	"	2 65
Hoboken	"	2 25
Jersey City	"	2 50
Lambertville	"	3 00
Millville	"	1 65

NEW JERSEY—Continued.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
Bloomfield	Coal	$3 25
Morristown	"	3 00
Mount Holly	"	2 75
New Brunswick	Lowe and coal	2 50
Newton	Coal	3 20
Passaic	Coal and oil	3 00
Paterson	Coal	2 00
Paterson—People's Co.	Campbell and Hanlon	1 50 to 2 10
Perth Amboy	Coal	2 50
Phillipsburg	"	2 25
Rahway	"	3 00
Salem	"	2 50
Vineland	"	3 00

NEW YORK.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
Albany	Coal	2 50
Albion	"	3 50
Amsterdam	Coal and oil	2 50
Auburn	Coal	2 25
Ballston Spa	Petroleum	4 00
Batavia	Coal	3 00
Bath	Crude oil	5 00
Binghampton	Coal	2 50
Brockport	"	3 00
Brooklyn	"	2 00
Brooklyn—Metropolitan *	W. G.	2 50
Brooklyn—Nassau	"	2 00
Brooklyn—People's *	W. G.	2 00
Brooklyn—Williamsburg	"	2 00
Buffalo	"	2 25
Buffalo—Citizens	"	2 25
Canandaigua	"	3 50
Clyde	Lowe	3 00
College Point	Coal	2 00
Corning	"	3 50
Cortland	"	2 50
Danville	Naphtha	4 00
Delhi	Water gas	2 50
Dunkirk	Coal	2 50
Fishkill	"	3 50
Flatbush	"	3 00
Fort Plain	Lowe	4 00
Fredonia	Natural gas	2 50
Fulton	Coal	3 50
Genesee	"	2 50
Geneva	Wood and oil	3 00
Glen's Falls	Coal	3 50
Greenbush	"	3 50
Hempstead	"	3 00
Hornellsville	"	3 00
Ithaca	"	2 00
Jamaica	"	3 00
Jamestown	"	2 00

NEW YORK—Continued.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
Johnstown	Coal	$2 50
Le Roy	"	3 00
Little Falls	"	3 00
Lockport	"	2 50
Long Island City	Mackenzie	2 00
Lyons	Coal	3 00
Malone	"	4 50
Middletown	"	2 50
Mt. Vernon	"	3 00
Newburg	Lowe	2 25
New Rochelle	Coal	3 50
New York	Tessie du Motay	2 25
New York—Harlem	Coal	2 25
New York—Knickerbocker	Tessie du Motay	2 25
New York—Manhattan	Coal	2 25
New York—Metropolitan	"	2 25
New York—Municipal	Tessie du Motay	2 25
New York—Mutual	Kennedy's patent	2 25
East New York	Coal	3 00
Niagara Falls	"	3.00
Norwich	"	3 00
Nyack	Hanlon's patent	3 00
Ogdensburg	Coal	3 00
Palmyra	"	3 00
Penn Yan	Brewer's oil patent	2 50
Plattsburg	Coal	3 00
Port Chester	"	2 50
Port Jervis	Lowe	2 50
Poughkeepsie	Coal	1 75
Rochester	"	1 25
Rochester—Citizen	"	1 25
Rochester—Municipal	Petroleum and water gas	1 25
Rome	Coal	3 00
Rondout	Allen-Harris	3 00
Sag Harbor	Hanlon's patent	4 00
Saratoga Springs	Lowe	2 50
Saugerties	Coal	3 00
Schenectady	"	2 50
Seneca Falls	"	2 75
Stapleton	Coal	3 00
Syracuse	"	2 00
Tarrytown	"	3 00
Troy	"	3 00
Troy "Citizens'"	Tessie du Motay	3 00
West Troy	Coal	3 50
Warsaw	"	3 50
Watertown	"	3 00
Watkins	"	3 00
Westfield	Natural and coal and oil	3 00
Whitehall	Coal	3 00
White Plains	"	3 80
Yonkers	Slade	2 00
Yonkers "West Chester"	Strong	2 00

NORTH CAROLINA.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
Charlotte	Rosin	$5 00
Fayetteville	"	5 00
New Berne	Lowe	3 00
Salisbury	Rosin and wood	5 00
Wilmington	"	2 50

OHIO.

Ashland	Coal	2 25
Athens	"	2 50
Barnesville	"	2 35
Bellaire	"	2 00
Bellefontaine	"	1 50
Canton	"	2 25
Chillicothe	"	2 40
Cincinnati	"	1 60
Circleville	"	2 60
Cleveland	"	1 65
Columbus	"	1 80
Dayton	"	2 25
Defiance	J. D. Patton's patent	10 00
Delaware	Coal	2 00
Elyria	Lowe	2 20
Galion	Coal	2 00
Gallipolis	"	3 00
Hamilton	"	2 50
Hillsboro	"	3 00
Ironton	"	2 70
Kenton	"	2 00
Lancaster	"	2 50
Lima	"	3 00
London	"	3 00
Mansfield	"	2 00
Marietta	"	3 50
Mt. Vernon	"	2 25
Newark	"	2 50
New Philadelphia	"	3 00
Oberlin	"	2 50
Painesville	"	2 50
Piqua	"	2 50
Ravenna	"	2 50
Ripley	"	2 50
Sandusky	"	2 00
Sidney	"	2 50
Springfield	"	2 00
Steubenville	"	1 90
Tiffin	"	2 50
Toledo	"	2 20
Troy	"	2 65
Van Wert	"	1 80
Warren	"	2 00
Washington	"	2 75
Wellsville	"	2 50
Wilmington	"	3 00

OHIO—Continued.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
Youngstown	Coal	$1 60
Zanesville	"	2 00

OREGON.

Portland	Coal	3 50

PENNSYLVANIA.

Allegheny	Coal	1 25
Allentown	"	2 50
Altoona	"	2 00
Ashland	Patton's patent	10 00
Beaver Falls	Coal	2 00
Bellefonte	"	3 00
Bethlehem	Lowe	2 37½
Bethlehem—Gas and Water Company	Coal	2 70
Bristol	Hanlon's patent	2 50
Butler	Coal	2 00
Catasauqua	Lowe	2 50
Carbondale	Coal	3 50
Carlisle	Lowe	2 50
Coatesville	Coal	3 00
Columbia	Lowe	3 00
Corry	Coal	3 00
Danville	"	3 00
Easton	"	2 00
Erie	"	2 50
Franklin	"	2 50
Freeport	"	3 00
Gettysburg	"	3 50
Greensburg	"	2 47
Harrisburg	"	2 00
Harrisburg—People's	Lowe	2 00
Honesdale	"	3 00
Huntingdon	Coal	3 00
Indiana	"	2 00
Johnstown	"	2 00
Lancaster	Lowe	2 00
Lock Haven	Coal	2 00
Meadville	"	2 00
Media	"	2 80
Milton	"	3 00
New Castle	"	2 00
Newton	Smith & Goldthrop	3 50
Norristown	Coal and oil	2 00
Oil City	Coal	2 50
Parker City	Smith & Goldthrop	6 50
Philadelphia	Coal	2 00
Philadelphia—Northern Liberties	"	2 00
Philadelphia—West Manayunk	Hanlon's patent	1 50
Pittsburg	Coal	1 00
Pittsburg—Consolidated	Mackenzie	2 00

PENNSYLVANIA—Continued.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
Pittsburg—East End	Coal	$2 00
Pittsburg—South Side	"	1 60
Pittsburg—West Pittsburg	"	1 80
Pittston	Lowe	3 00
Plymouth	Patton's patent	1 88
Pottstown	Coal	2 70
Pottsville	Lowe	2 25
Reading	Coal and naphtha	2 37½
Royersford	Hanlon's patent	3 20
Scranton	Lowe	2 00
Scranton—Hyde Park	"	2 25
Sewickly	Coal	2 00
Sharon	"	1 25
Sharpsburg	"	2 00
Shippensburg	Lowe	2 50
Sunbury	Kutz's patent	2 00
Tamaqua	Coal	4 00
Titusville	"	2 60
Towanda	"	3 00
Uniontown	"	2 00
Warren	"	3 00
Washington	"	2 00
West Chester	Coal and Lowe	2 80
West Newton	Smith & Goldthrop	2 00
Wilkesbarre	Lowe	2 50
Williamsport	"	2 50
York	Coal	2 00

RHODE ISLAND.

Bristol	Coal	2 50
East Greenwich	Crude petroleum	6 00
Pawtucket	Coal	1 80
Providence	"	2 10
Warren	Hanlon's patent	4 00
Woonsocket	Coal	2 20

SOUTH CAROLINA.

Charlestown	Coal	2 85
Columbia	"	4 50
Spartanburg	Rosin	4 00

TENNESSEE.

Brownsville	Coal	2 50
Chattanooga	"	2 70
Clarksville	"	3 00
Gallatin	Oil	2 00
Jackson	"	4 00
Memphis	Coal	3 00
Murfreesboro	"	4 00
Nashville	"	2 10

TEXAS.

COMPANIES.	PROCESS OF MANUFACTURE.	PRICE PER 1,000 FT.
Dallas	Coal	$3 00
Denison	"	3 50
Fort Worth	"	4 00
Houston	"	4 00
Paris	"	3 50
San Antonio	"	5 00
Sherman	"	3 50
Waco	H. H. Edgerton's patent	3 50

VERMONT.

Brattleboro	Lowe	3 15
Burlington	"	3 00
Montpelier	Hanlon's patent	2 00
Rutland	Lowe	3 00
Windsor	Hanlon's patent	5 00
Woodstock	Olefiant	10 00

VIRGINIA.

Alexandria	Coal	1 80
Charlottsville	"	3 00
Danville	"	3 36
Fredericksburg	"	3 00
Lynchburg	"	2 75
Norfolk	Coal and oil	1 90
Petersburg	Coal	3 00
Portsmouth	"	2 70
Richmond	"	2 00
Staunton	"	2 50
Winchester	"	3 00

WASHINGTON TERRITORY.

Walla Walla	Wood and oil	6 00

WEST VIRGINIA.

Martinsburg	Coal	3 00
Wheeling	"	1 50

WISCONSIN.

Appleton	Lowe and coal	3 00
Beloit	Coal	3 30
Fond du Lac	"	3 30
Green Bay	"	3 00
Janesville	"	2 50
Kenosha	"	3 00
Lacrosse	"	3 00
Madison	"	3 50
Milwaukee	"	2 25
Neenah	J. D. Patton's patent	8 00
Oshkosh	Coal	3 00
Racine	"	2 50
Sheboygan	"	3 00
Watertown	"	3 00

PROCESSES IN DIFFERENT CITIES.

STATE.	CITY.	PROCESS.	IN USE.	PRICE.
New York	Rochester	Petroleum and water gas	1	$1 25
Indiana	Valparaiso	Oil	1	1 50
Pennsylvania	West Manyunk	Hanlon's patent	1	1 50
Connecticut	Danbury	Naphtha	1	1 80
Pennsylvania	Plymouth	Naphtha, Patton's pat.	1	1 88
Maryland	Baltimore	Lowe and coal gas	1	1 90
Indiana	Seymour	Kutz's patent	1	2 00
Indiana	Warsaw	Kutz's patent	1	2 00
Kentucky	Lebanon	Oil	1	2 00
Michigan	Detroit	Benzine and coal	1	2 00
New York	Long Island City	Mackenzie	1	2 00
New York	Yonkers	Slade	1	2 00
New York	Yonkers—Westchester	Strong	1	2 00
Pennsylvania	Harrisburg	Lowe	1	2 00
Pennsylvania	Lancaster	Lowe	1	2 00
Pennsylvania	Norristown	Coal and oil	1	2 00
Pennsylvania	Pittsburg	Mackenzie	1	2 00
Pennsylvania	Scranton	Lowe	1	2 00
Pennsylvania	Sunbury	Kutz's patent	1	2 00
Pennsylvania	West Newton	Smith & Foldthorp	1	2 00
Tennessee	Gallatin	Oil	1	2 00
Vermont	Montpelier	Hanlon's patent	1	2 00
New Jersey	Paterson	Campbell & Hanlon	1	2 10
Ohio	Elyria	Lowe	1	2 20
Illinois	Pullman	Lowe	1	2 25
New York	Newbury	Lowe	1	2 25
New York	New York	Tessie du Motay	1	2 25
New York	New York—Knickerbocker	Tessie du Motay	1	2 25
New York	New York—Municipal	Tessie du Motay	1	2 25
New York	New York—Mutual	Kennedy's patent	1	2 25
Pennsylvania	Scranton	Lowe	1	2 25
Pennsylvania	Bethlehem	Lowe	1	2 37½
Pennsylvania	Reading	Coal and naphtha	1	2 37½
Connecticut	Middletown	Lowe	1	2 50
Connecticut	Willimantic	Hanlon Oil	1	2 50
Iowa	Independence	Patton's patent	1	2 50
Iowa	Waterloo	Patton's patent	1	2 50
Illinois	Chicago	Coal oil	1	2 50
Illinois	Macomb	Patton's patent	1	2 50
New Jersey	New Brunswick	Lowe and coal	1	2 50
New York	Amsterdam	Coal and oil	1	2 50
New York	Delhi	Water gas	1	2 50
New York	Fredonia	Natural gas	1	2 50
New York	Penn Yan	Oil	1	2 50
New York	Port Jervis	Lowe	1	2 50
New York	Saratoga Springs	Lowe	1	2 50
North Carolina	Wilmington	Rosin and wood	1	2 50

STATE.	CITY.	PROCESS.	IN USE.	PRICE.
Pennsylvania	Bristol	Hanlon's patent	1	$2 50
Pennsylvania	Catasauqua	Lowe	1	2 50
Pennsylvania	Carlis e	Lowe	1	2 50
Pennsylvania	Columbia	Lowe	1	2 50
Pennsylvania	Shippensburg	Lowe	1	2 50
Pennsylvania	Wilkesbarre	Lowe	1	2 50
Pennsylvania	Williamsport	Lowe	1	2 50
New Hampshire	Dover	Hanlon's patent	1	2 70
Illinois	Sterling	Lowe	1	2 80
Pennsylvania	Westchester	Coal and Lowe	1	2 80
Indiana	Goshen	Petroleum	1	3 00
Iowa	Oskaloosa	Coal oil	1	3 00
Minnesota	Faribault	Naphtha	1	3 00
New Hampshire	Claremont	Oil	1	3 00
New Jersey	Atlantic City	Petroleum and water gas	1	3 00
New Jersey	Passaic	Coal and oil	1	3 00
New York	Clyde	Lowe	1	3 00
New York	Geneva	Wood and oil	1	3 00
New York	Nyack	Hanlon's patent	1	3 00
New York	Rondout	Allen-Harris	1	3 00
New York	Troy	Tessie du Motay	1	3 00
New York	Westfield	Coal and oil	1	3 00
North Carolina	New Berne	Lowe	1	3 00
Pennsylvania	Columbia	Lowe	1	3 00
Pennsylvania	Homesdale	Lowe	.	3 00
Pennsylvania	Pittston	Lowe	1	3 00
Vermont	Burlington	Lowe	1	3 00
Vermont	Rutland	Lowe	1	3 00
Wisconsin	Appleton	Lowe and coal	1	3 00
Vermont	Brattleboro'	Lowe	1	3 15
Pennsylvania	Royersford	Hanlon's patent	1	3 20
California	Oakland	Coal and Lowe water	1	3 50
California	San Jose	Lowe water and coal	1	3 50
Delaware	Milford	Lowe water	1	3 50
Indiana	Greensburg	Oil	1	3 50
Indiana	Rushville	Oil and naphtha	1	3 50
Indiana	Shelbyville	Coal and naphtha	1	3 50
Massachusetts	Great Barrington	Petroleum	1	3 50
Mississippi	Holly Springs	J. D. Kutz's patent	1	3 50
New Hampshire	Keene	Lowe	1	3 50
Pennsylvania	Newtown	Smith & Goldthrop	1	3 50
Texas	Waco	H. H. Edgerton's patent	1	3 50
Arkansas	Hot Springs	Wood	1	4 00
Massachusetts	Southbridge	Crude oil	1	4 00
New Jersey	Arlington	Smith & Goldthrop	1	4 00
New York	Ballston Spa	Petroleum	1	4 00
New York	Danville	Naphtha	1	4 00
New York	Fort Plain	Lowe	1	4 00
New York	Sag Harbor	Hanlon's patent	1	4 00
Rhode Island	Warren	Hanlon's patent	1	4 00
South Carolina	Spartansburg	Rosin	1	4 00
Tennessee	Jackson	Oil	1	4 00
Colorado	Georgetown	Hanlon Oil	1	4 50
Alabama	Talladega	Wood and coal	1	5 00

STATE.	CITY.	PROCESS.	IN USE.	PRICE.
New Hampshire.	Laconia	Crude oil	1	$5 00
New York	Bath	Crude oil	1	5 00
North Carolina	Charlotte	Rosin	1	5 00
North Carolina	Fayetteville	Rosin	1	5 00
North Carolina	Salisbury	Rosin and wood	1	5 00
Vermont	Windsor	Hanlon's patent	1	5 00
California	Oroville	Oil, coal and pine wood	1	5 50
Nevada	Carson City	Shale and pitch pine	1	6 00
Massachusetts	Lexington	Hanlon's patent	1	6 00
Washington Ter.	Walla Walla	Wood and oil	1	6 00
Nevada	Virginia City	Shale and pitch pine	1	6 50
Pennsylvania	Parker City	Smith & Goldthorp	1	6 50
Massachusetts	Amherst	Naphtha	1	7 50
Illinois	Dixon	J. D. Patton's patent	1	8 00
Wisconsin	Neenah	J. D Patton's patent	1	8 00
California	Placerville	Pine wood	1	10 00
Illinois	Morris	Crude petroleum	1	10 00
Maryland	Cambridge	Oil	1	10 00
Ohio	Defiance	J. D. Patton's patent	1	10 00
Pennsylvania	Ashland	Patton's patent	1	10 00
Vermont	Woodstock	Olefiant	1	10 00
			120	

Average cost per 1,000 cubic feet..$3 73½.

RECAPITULATION.

COAL PROCESS.

NUMBER OF COMPANIES.	PRICE OF GAS PER 1,000 CUBIC FEET.
2	$1 00
3	1 25
3	1 50
3	1 60
3	1 65
3	1 75
5	1 80
1	1 90
53	2 00
1	2 05
2	2 10
1	2 12
3	2 20
28	2 25
1	2 35
1	2 40
1	2 47
80	2 50
6	2 60
1	2 65
12	2 70
9	2 75
2	2 77
1	2 80
4	2 85
113	3 00
1	3 15
2	3 20
9	3 25
1	3 30
1	3 36
50	3 50
2	3 60
1	3 61
3	3 75
1	3 80
20	4 00
1	4 25
3	4 50
1	4 70
8	5 00
446	$113 98

Average cost, ... $2 78

PATENT PROCESS.

NUMBER OF COMPANIES.	PRICE OF GAS PER 1,000 CUBIC FEET.
1	$1 25
2	1 50
1	1 80
1	1 88
1	1 90
16	2 00
1	2 10
1	2 20
8	2 25
2	2 37½
20	2 50
1	2 70
2	2 80
18	3 00
1	3 15
1	3 20
11	3 50
10	4 00
1	4 50
7	5 00
1	5 50
3	6 00
2	6 50
1	7 50
2	8 00
5	10 00
120	$97 10

Average cost.............. $3 73½

APPENDIX E. PAPER 16.

HOUSE, No. 36.

Commonwealth of Massachusetts.

Office of Gas Inspection, 32 Hawley Street,
Boston, January, 1882.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts.

The undersigned respectfully submits the following

REPORT:

The work of inspecting gas-meters has gone on in about the usual manner during the past year. The present system of inspection by a state official was introduced by Professor William B. Rogers in the year 1861, when the first law on the subject in Massachusetts was passed. Before that time the meters had been proved by various standards, among which were meter-provers imported, ready graduated, from England; a vessel holding a certain quantity of water, graduated by Professor Horsford of Harvard University; and a cubic-foot measure imported from England by the Boston Gas Street Company. This last instrument is sufficiently accurate, but is rather inconvenient to use.

The legal standard of capacity for the sale of gas in Massachusetts is the cubic foot, which is defined as a measure capable of holding a certain definite quantity of water—about 62⅓ pounds—at a given temperature and atmospheric pressure. A standard cubic foot measure was constructed by E. S. Ritchie under the direction of Professor Rogers, the State standard weights being used for weighing the water: and this measure has been used as the standard measure since that time.

The apparatus is an admirable piece of workmanship, and is very easily manipulated; but accurate results are to be obtained only by using great care, and under certain atmospheric conditions. The cubic-foot apparatus is not used directly to test meters, but in graduating meter-provers. All the larger gas-light companies have a meter-prover, and some of them have several. The meter-provers are from three to twenty feet in capacity, the usual size being five feet. The greater part of them

were graduated when the State inspection was first established and the others at various times since then, about twenty having been graduated by the present inspector.

The meters are divided into two classes,—first, new or repaired meters, which are supposed to be correct; second, meters which have been some time in use, and are suspected by the gas-consumer to be incorrect. The first class of meters are inspected either at the State inspector's office, at the manufactory, or at the gas companies' repair-shops.

During the past year about one thousand (1,000) meters have been inspected at the office; and of the remainder, about one-half have been inspected at the factory, the other half at the repair-shops. The suspected meters have been inspected at the office. All meters are required to have an inspection-badge and date affixed to them before being used. All meters in use are inspected whenever the consumer requires.

During the year 1881, seven thousand and ninety-five (7,095) meters have been inspected. Of this number, six thousand nine hundred and fifty (6,950) were either new, or had just been repaired. This class of meters are usually found correct; but if any faulty ones are found, they are returned for repairs, and then tested again. The number of suspected meters, or at least of those brought to the office for inspection, was one hundred and forty-five. Of this number, forty-one were fast, or registered against the consumer, the average error being five and sixty-eight one-hundredths per cent; seventy-two were within the limits allowed by law, namely, two per cent either way, the average error being eight hundredths per cent slow; and twenty-eight were slow, or registered against the company, the average error being six and forty-four hundredths per cent. The average error of all the "suspected" meters, leaving out of account four that would not register, was thirty-three hundredths per cent fast.

All the consumers' meters inspected were "dry" meters, as practically no consumers' "wet" meters are in use in Massachusetts. The results of the inspection in preceding years are given in the following table:

YEAR.	Fast Meters.		Correct Meters.	Slow Meters.		Total.	
		Per cent.			Per cent.		Per cent. fast.
1872	87	4.30	81	32	9.55	202	0 32
1873	100	5.43	95	40	6.61	238	1.18
1874	101	4.76	131	51	6.22	285	0.57
1875	123	5.99	142	39	8.17	314	1.33
1876	148	5.19	179	53	9.17	381	0.74
1877	93	4.79	125	34	11.00	257	0.28
1878	111	5.34	180	44	9.51	343	0.63
1879	83	5.00	91	18	16.20	193	0.64
1880	48	4.54	52	22	6 59	122	0.52
1881	41	5.68	72	28	6.44	141	0.33

Of course these meters cannot be taken as an exact average of those in use, as the consumer in almost all cases has suspected them of being fast. The table seems to show that the gas companies give the consumer as a whole all the gas that is charged to them; but that is a poor consolation to the man whose meter is ten per cent fast. It may be well to state that only three meters out of the one hundred and forty-five were more than ten per cent fast.

The law of 1861, while it provided fairly well for the inspection of gas-meters, was very deficient in regard to inspecting gas, the inspector being required to inspect the gas only at the request of the town or city authorities. Nevertheless, Professor Rogers made tests of the illuminating power at most of the places in the State using gas. For this purpose he made use of a portable photometer of his own design. He also made a few estimations of the impurities in the Boston gas. Mr. Fred. E. Stimpson, the successor of Professor Rogers, continued in the general lines laid down by his predecessor, his special contributions to the instruments and methods of gas inspection being an ingenious portable photometer and an improved candle-balance. The candle-balance is in quite general use at present; but the photometer was rather complicated, and had certain other faults. which left considerable to be desired. On the accession of the present inspector the chemical side of the question seemed to require the most attention; and the following apparatus was devised by him. A form of bulbs working with little pressure, and containing a given quantity of standard acid colored with cochineal, gives, by the change of color, a simple and accurate means of determining

the ammonia. This bulb apparatus is made by two gas apparatus manufacturers, and is used throughout the country; but the inspector derives no pecuniary profit from this or any other apparatus devised by him. After a good many experiments, an apparatus for the determination of sulphur was adopted, which answered the requirements, except that an aspirator was needed, and so could only be used in certain places. In this apparatus the gas was measured, then burned, and the products of combustion drawn through a horizontal condenser, filled with glass beads, and containing some ammonia water.

Occasionally it is quite important to have a eudiometric analysis of the gas. An apparatus for such an analysis was devised, and a description of it published in "The American Journal of Arts and Sciences," for September, 1874.

This apparatus has been considerably used by chemists in this country having occasion to make such analyses. A new style of sulphur-apparatus was shown to be necessary by a call for a sulphur test coming from a place where no aspirator was attainable. The new apparatus is vertical, and works by the draught caused by the gas in burning. With the vertical form a mixture of ammonium nitrate and ammonia-water is used to absorb the sulphur acids. Comparative experiments showed that the vertical and horizontal forms of apparatus gave the same results. Where many sulphur determinations have to be made the ordinary gravimetric method is quite tedious, and many attempts have been made by various chemists to find a volumetric method both simple and accurate. The method used in this office, and described in the December number of "The American Journal of Arts and Sciences" for 1877, is perhaps as rapid as any accurate method, although several good ones have been described by English chemists. The present inspector has also contributed a style of portable photometer to those previously in existence. The photometer has been used in making about one hundred and fifty inspections, and has proved itself a serviceable instrument. An instrument for determining the specific gravity of gas has been devised during the past year, and a description of it will probably soon be published.

While little change has taken place in the character of the meter inspection from the time it was first established, a great change has been made in the inspection of gas. Formerly the determinations were limited to the illuminating power of the gas, or sometimes the amount of carbonic acid was taken.

In the inspector's report for 1873 are given, for the first time, the candle-power, and quantities of sulphur and ammonia, for the gas of about a dozen of the larger Massachusetts companies. The number of companies reported gradually increased until two years ago, when the Legislature passed, at the suggestion of the gas inspector, a law requiring the gas of every company in the State supplying fifty consumers to be inspected at least twice a year, and one additional inspection for every four million feet of gas manufactured. The law gave fifteen candles as the legal minimum, and ten grains of ammonia and twenty grains of sulphur as the maximum, for one hundred feet of gas. Under this law, taking a city the size of Lawrence, for example, an inspection of its gas is made about once in three weeks; and the determination comprises candle-power and the quantities of sulphur and ammonia contained in the gas; and sometimes, if deemed necessary, a eudiometric analysis is also made.

In the report for last year it was stated that the companies at Chelsea, Dorchester, East Boston, Holyoke, and Jamaica Plain had not provided photometers, as required by law. At Chelsea and Holyoke the photometers were provided early enough in the year to cause no delay in the inspections. At Dorchester and Jamaica Plain the photometers were provided early in the fall, and about half the number of inspections required for the year were afterwards made. At East Boston the photometer was ready the last of December. While all the companies heretofore making fifteen million feet of gas a year are now provided with photometers, there are one or two companies that will make that quantity of gas during the present year that are not so provided. Of course, when the company had a stationary photometer away from the works, it was used in making the inspections; but none of the companies making less then fifteen millions feet of gas have any such photometers; and at these places the portable photometer above mentioned was used.

The number of inspections made is given below for each place. The inpections were distributed at irregular intervals, and no notice has ever been given when they were to occur. More inspections have been made in the winter than in any other season, and fewer in the summer, so as to follow the production of gas as closely as practicable. Almost all the inspections have been made at some distance from the works; but at Brockton, Easthampton, Plymouth, Quincy, and Wakefield, and occasionally elsewhere, the inspections have been made at the works, as there was no other available place.

Sugg's London burner No. D has been used in most of the inspections; but for some of the richer gases Nos. E and F have been used. For testing the gas at Amesbury, Athol, Chicopee Falls, Great Barrington, Ipswich, Lee, Leominster, Lexington, Middleborough, and Southbridge, where at least part of the gas was made from petroleum, a steatite "batswing" burner was used, and the gas burned at the rate of about three feet per hour. At all other places the gas was burned at the rate of five feet per hour, as near as was practicable; and in all cases the result is calculated at that rate. English standard candles were used, and corrections were made if the rate of burning differed from one hundred and twenty grains per hour. The candle is a very unsatisfactory standard; but is so convenient to use, and a really good standard is so hard to find, that it has held its place so far against all rivals. It is probable that another standard will soon be adopted for testing the London gas; and it is most likely that a gas composed of air and vapor of a certain specified petroleum product will be taken as the standard, and burned under the same conditions as the gas to be tested. This standard is said to be pretty nearly constant, while one standard candle may differ considerably from another of a different lot or make.

The results given are the average of the tests made during the past year:

Number of Inspections made.	Place or Company.	Candle Power.	Grains per 100 feet of gas	
			Ammonia. (NH_3)	Sulphur. (S_2)
2	Adams	16.8	1—	12.2
2	Amesbury	22.4	1—	6.1
3	Arlington	16.2	1—	17.1
2	Athol	40.7, 15.7	—	—
2	Attleborough	16.9	8.9	8.9
3	Beverly	17.5	18.9	14.2
52	Boston	19.12	4.18	13.7
3	Brockton	16.9	30.6	13.2
11	Brookline	17.38	11.79	12.69
21	Cambridge	16.65	2.78	8.64
14	Charlestown	16.51	1.19	16.35
7	Chelsea	17.60	1.33	12.48
2	Chicopee	16.5	2.2	10.1
2	Chicopee Falls	35.9	—	—
4	Clinton	17.1	9.1	11:6
2	Danvers	17.7	2.7	12.6

NUMBER OF INSPECTIONS MADE.	PLACE OR COMPANY.	CANDLE POWER.	GRAINS PER 100 FEET OF GAS.	
			AMMONIA. (NH_3)	SULPHUR. (S_2)
3	Dedham	17.2	9.0	11.4
4	Dorchester	17.4	2.7	11.4
2	East Boston	15.9	9.6	8.5
3	Easthampton	16.7	32.7	11.6
13	Fall River	16.44	14.50	11.10
4	Fitchburg	16.6	1—	11.7
3	Gloucester	17.3	14.2	12.1
2	Great Barrington	16.9, 27.2	—	—
3	Greenfield	15.5	1—	8.7
6	Haverhill	17.40	4.55	14.33
8	Holyoke	17.34	1—	14.66
1	Ipswich	28.5	—	5.3
4	Jamaica Plain	17.8	78.4	12.9
16	Lawrence	17.29	1.44	15.54
1	Lee	37.3	—	—
2	Leominster	27.5	—	8.4
2	Lexington	25.0	—	—
29	Lowell	16.86	7.76	13.98
9	Lynn	16.54	1—	14.16
5	Malden	16.9	3.8	10.0
4	Manufacturers of Fall River	16.6	10.6	12.2
2	Marblehead	16.8	5.0	9.6
2	Marlborough	16.9	1.4	11.9
2	Middleborough	24.4	—	—
3	Milford	16.1	1.2	11.3
2	Nantucket	17.6	50.8	8.9
3	Natick	16.6	2.1	14.1
9	New Bedford	17.31	4.32	9.58
3	Newburyport	16.6	4.2	12.4
9	Newton	16.98	11.23	12.70
4	North Adams	16.5	1—	16.2
3	Northampton	17.3	3.0	12.9
4	North Attleborough	16.2	16.7	9.3
4	Pittsfield	16.6	1—	14.2
2	Plymouth	17.4	15.3	8.3
2	Quincy	17.3	28.4	12.5
27	Roxbury	18.68	6.80	9.80
10	Salem	16.93	4.85	9.00
12	South Boston	18.00	5.48	11.60
2	Southbridge	22.4	—	—
14	Springfield	16.53	9.52	12.76
6	Taunton	17.37	1.65	13.25
2	Wakefield	16.6	23.3	13.2
5	Waltham	16.5	11.6	13.1
2	Webster	17.6	2.3	6.4
2	Westfield	16.8	1—	15.6
4	Woburn	17.0	6.5	12.7
14	Worcester	16.40	1—	16.99

The following companies have been found to have more than ten (10) grains of ammonia in one hundred (100) feet of their gas on three consecutive inspections: Brockton, Easthampton, Fall River, Jamaica Plain, Lowell, Quincy, Springfield, Wakefield, and Waltham. In each case the town or city authorities were notified that they were entitled to collect a fine from the company.

At Easthampton, Fall River, Lowell, Springfield, and Waltham, the ammonia has since been reduced, so that it is no longer present in harmful quantities. The other companies mentioned, I am told, are intending to add to their plant the necessary apparatus for taking the excess of ammonia from their gas.

The presence of any considerable quantity of ammonia in gas is apt to cause a shrinkage of the diaphragms of the meters, which consequently do not pass as much gas as is registered. Ammonia is somewhat injurious in other ways; but the resultant damage is usually trifling. It is easily removed from gas by means of water and a suitable apparatus, if the gas is first properly cooled.

The apparatus in which the water is applied to the gas is called a washer or scrubber, according to shape and position; but in both the result aimed at is to present as much wetted surface to the gas as possible, and to cause the gas and water to pass in opposite directions, although this last condition is sometimes neglected. Where iron purification is used, there is generally only a small quantity of ammonia left in the gas.

Almost the whole amount of ammonia used in the arts is obtained as a secondary product from the manufacture of coal gas: and some of the larger companies are deriving quite an income from that source.

In general, this year's report shows fully as much ammonia as was reported last year; but it is to be remembered that the larger proportion of last year's inspection was done in cold weather, when less ammonia is usually found, while this year's inspection was fairly distributed throughout the year; and the next report will probably show a considerable reduction.

As regards light, most of the companies furnish a fairly satisfactory gas, the average of only two of the companies falling below sixteen candles. Twenty-nine (29) of the companies, or about one-half of the whole number, furnish gas averaging from sixteen to seventeen candles. Nineteen (19) companies, or about one-third, furnish from seventeen (17) to eighteen (18) candle

gas, and three (3) companies, all in Boston, furnish from eighteen to twenty candle gas. These companies all use coal for producing the main body of their gas, although a number of them use petroleum for enriching it.

Inspections were made at ten (10) places where the gas was made from petroleum, and then mixed with air to prevent the flame from smoking. The quantity of air added varies at different times and places; but it usually forms less than one-half the mixture. This mixed gas is from twenty to forty candle power. As regards impurities, it contains a small amount of sulphur, and no ammonia; but sulphuretted hydrogen is sometimes present. There has been no great change from the past few years as regards the amount of sulphur present in the gas. At quite a number of inspections more than twenty grains of sulphur have been found: but at no place have more than twenty grains been found on three consecutive inspections.

At thirteen places an average of fourteen or more grains of sulphur per hundred cubic feet was found. Seven companies use iron purification to some extent; and these seven companies were all found to have fourteen or more grains of sulphur. Some of the companies using the iron purification have great difficulty in keeping their sulphur within the limits allowed by law. Iron purification removes sulphuretted hydrogen quite well, but seems to have little action on carbon bisulphide. The fact is carbon bisulphide has very little affinity for hardly any thing except triethylphosphine, which cannot be used for purifying gas. Carbon bisulphide forms rather unstable salts, called sulphocarbonates, by its union with alkaline sulphydrates; and all the practical processes for the purification of gas from sulphur are based on this formation of sulphocarbonates.

Crude gas contains, among other substances, the following, which it is desirable to remove—cyanogen, sulphuretted hydrogen, carbonic acid, ammonia, and their various compounds.

It is scarcely probable that any considerable quantity of cyanogen, or any its compounds, can get beyond the scrubber. And so the only substances that need to be considered are sulphuretted hydrogen, carbonic acid, carbon bisulphide, and ammonia, and their compounds. Carbonic acid and sulphuretted hydrogen are faintly acid in their properties, while ammonia is decidedly alkaline, and carbon bisulphide is neutral. Ammonium carbonate and sulphydrate are volatile and not very stable compounds, and, if they are really formed in the gas, are partly

decomposed in the scrubbers. Ammonia is absorbed by water along with quite a quantity of sulphuretted hydrogen and carbonic acid. A part of the carbon bisulphide combines with the ammonium sulphydrate to ammonium sulphocarbonate, and is absorbed by water.

The calcium hydrate in the purifiers acts on both the sulphuretted hydrogen and the carbonic acid, forming calcium sulphydrate and carbonate, the latter being the more stable compound. After these compounds are formed, they are still exposed to the action of sulphuretted hydrogen and carbonic acid ; and the calcium sulphide is partly decomposed by the carbonic acid, with the formation of calcium carbonate, while the liberated sulphuretted hydrogen is carried along, and unites with a fresh portion of calcium hydrate. This decomposition of calcium sulphydrate by carbonic acid is only partial in the conditions which occur in the purification of gas. The carbon bisulphide is not acted on by the calcium carbonate or calcium hydrate, but only by the calcium sulphydrate ; calcium sulphocarbonate being formed ; hence it is desirable to keep the gas in contact with as much foul lime as possible ; but it is necessary to keep sufficient clean lime in the purifiers to absorb all the sulphuretted hydrogen.

In gas works there are usually four purifiers, three of which are in use while the other is being emptied and refilled, or kept in reserve. Some purifiers are large enough so that in summer a purifier has to be changed only once a month; while some are so small that in winter a change is necessary every day.

At many places the custom prevails of changing as soon as any sulphuretted hydrogen is detected at the outlet of the second purifier, thus keeping the third full of clean lime. But where not more than one change in four days is necessary, such a custom is not to be recommended ; for in this case there is not as much calcium sulphydrate to act on the carbon bisulphide as if the third purifier was allowed to do some of the work.

To keep the gas free from sulphuretted hydrogen is about as much as can be expected where a change has to be made every day.

In some cases iron and lime purification are used together, and the order in which they are used is of considerable importance. If the iron is used first, the sulphuretted hydrogen is removed, and no calcium sulphydrate is formed, and the carbon bisulphide remains in the gas unabsorbed. The best arrangement is to use the lime first, and to change the first purifier only when carbonic

acid is shown at the outlet of the last lime purifier. In this way all are kept well charged with calcium sulphydrate for the removal of carbon bisulphide; and the sulphuretted hydrogen is removed by the iron oxide, for which duty it is well adapted. This combination of lime and iron purification is probably the most desirable method in use, as it is as efficient as lime alone, and less expensive.

When alternate layers of lime and iron are used, the purification is less effective than when lime is used alone, and more expensive than when iron is used alone. Unfortunately, most gas works are arranged with a centre seal, which causes each purifier in succession to be the first for the gas to enter, and so does not admit of the best arrangement of iron and lime purification. There is another arrangement of valves that permits the purifiers to be used in any order; but its adoption while the works were in operation would be difficult.

There is no doubt that the centre seal is more simple to use when the gas is to be sent through the purifiers in the particular order to which it is adapted, as the seal has to be turned only a quarter revolution for each change,

With the valves either two or four changes for each change of purifiers must be made, to send the gas through the purifiers in the order observed when using the centre seal; but if the two first purifiers are to be used for lime, and the two last for iron, one change of valves is needed to effect a change of purifiers. In some cases it might be desirable to add two purifiers to the existing four, the added two to be used for lime, and the present ones used for iron. The object of using iron and lime purification conjointly is more to reduce the cost and offensiveness than to increase the efficiency of the present lime purification.

The larger Massachusetts companies compare favorably with those of London in regard to candle-power, but contain rather more sulphur, and generally much more ammonia. The gas supplied to the city of London was inspected at least fifteen hundred (1,500) times between May and November, 1881. These inspections showed an average of a little more than seventeen candle-power, and of a little less than eleven grains of sulphur, per one hundred feet of gas. Only two inspections showed more than two and one-half grains of sulphur per hundred feet. There was seldom found as much as one grain of ammonia per hundred feet. The law there demands a minimum of sixteen candles, and a maximum of four grains of ammonia and seventeen grains of

sulphur, per hundred feet. The combined iron and lime purification is used in London. Formerly, when iron alone was used there, it was found impossible to keep the sulphur as low as twenty grains per hundred feet of gas.

Of late years there has been a considerable revival of the plan of decomposing steam by red hot carbon, and either using the resulting gases for heating purposes, or, by mixing them with petroleum gas, using the mixture for lighting. A number of gaslight companies in and near New York City are using this mixture; others of them use wood gas to dilute petroleum gas. These mixtures contain considerable quantities of carbonic oxide.

It has been claimed recently that carbonic oxide is an anæsthetic rather than a poison, and that it is no more injurious than many other components of coal gas.

I have made no experiments myself on this subject, but have taken pains to compile the opinions and experiments of the most noted chemists, physiologists, and toxicologists, translating the French and German authors.

"A bird placed in a bell of this gas [carbonic oxide] was killed before it could be taken out. . . . One of us having breathed some, immediately experienced dizziness, and scarcely kept from falling."—DESORMES AND CLEMENT: *Annalles de Chemie*, vol. 29, p. 56.

"No decisive experiment exists at present on the amount of change in air rendered asphyxial by the burning of carbon. I was astonished to see an atmosphere containing from three to four per cent. of carbonic oxide become suddenly fatal for a large dog, while, to produce the same effect, at least from thirty to forty per cent. of pure carbonic acid is necessary. I have shown in my memoir that the effect was independent of temperature.

"How is the poisonous energy of an atmosphere irrespirable under these conditions to be explained, since the amount of carbonic acid alone, or the observed deficiency of oxygen, are insufficient to produce the results?"

[The following experiment was made: a large dog was placed inside a closed space, and was observed through a window; a tube permitted the taking of samples of the air inside. Some pieces of lighted baker's breeze were placed on the grate, which was then filled with cold breeze, and the door closed. In five or six minutes the flame was at the top of the breeze; the uneasiness of the animal was already visible. At the end of ten min-

utes he fell exhausted, and in twenty minutes was dead. At this time a candle burned inside as brilliantly as ever. It was only in ten minutes after the death of the dog that the candle went out, gradually declining in brilliancy. At this time a sample of air was collected and analyzed with the following result:

Carburetted hydrogen	.04
Oxygen	19.19
Nitrogen	75.62
Carbonic acid	4.61
Carbonic oxide	.54
	100.00

Any olefiant gas would have been absorbed by the sulphuric acid used.]

"The dangerons effects of carbonic oxide and carburetted hydrogen have already been made known by some observers. Samuel White, having taken some inhalations of carbonic oxide, lost consciousness, and was with difficulty brought to life; it was necessary to have recourse to oxygen. M. Devergie also considers this gas harmful, contrary to the conclusions of Nysten. As to carburetted hydrogen, it can, according to Seguin, produce fainting when it composes one-tenth of the air.

"The proportion of these two gases shown in the analyses do not at first seem capable of exerting a harmful action on the economy; but some experiments made on animals have demonstrated to me that even a very small quantity of carbonic oxide can cause severe and even fatal accidents. Thus five per cent. in air instantly killed a sparrow, while one per cent. killed at the end of two minutes at the furthest. On the contrary, when one per cent. of marsh gas is present, no hurtful effect is produced in a much longer time. Olefiant gas, when present to the extent of several per cent. in air, produced no offect.

"Carbonic oxide, then, appears to play the principal role in the fatal action of burning charcoal."—LEBLANC; *Comtes Rendus*, vol 14, p. 867. A fuller account is given in *Annalles de Chemie et Physique* for 1842, 3d series, vol 5, pp. 223–268.

"It [carbonic oxide] acts as a strong poison, producing death when inhaled even in very small quantities."—ROSCOE: *Chemistry*, London, 1869, p. 91.

"Carbon monoxide is extremely poisonous; much more so than carbon dioxide."—FOWNES: *Chemistry*, Philadelphia, 1878, p. 164.

"It [carbonic oxide] is an extremely poisonous gas, being capable of displacing the oxygen in blood, owing to the formation of a compound with the hæmoglobin with which the oxygen is ordinarily combined."—ARMSTRONG: *Encyclopædia Britannica*, American reprint, 1877, vol. 5, p. 78.

"Carbon monoxide is an excessively poisonous gas. It acts rapidly on the blood, combining with the hæmoglobin to form carboxy hæmoglobin, a body possessed of a bright red color."—THORPE: *Chemistry*, Glasgow, 1873, p. 237.

"It [carbonic exide] extinguishes combustion just as hydrogen does, and destroys animal life. Unlike hydrogen and nitrogen, however, it is a true poison. It destroys life, not negatively, by mere suffocation or exclusion of oxygen, but by direct noxious action. Even when largely diluted with air, it is still poisonous, producing giddiness, insensibility, and finally death. It is the presence of this gas which occasions the peculiar sensation of oppression and headache which is experienced in rooms into which the products of combustion have escaped from fires of charcoal or anthracite. Carbonic oxide is very much more poisonous than carbonic acid. Much of the ill repute which attaches to carbonic acid really belongs to carbonic oxide; for, since both these gases are produced by burning charcoal, many persons are liable to confound them; but carbonic acid is, comparatively speaking, almost innoxious. Carbonic acid, it is true, is somewhat poisonous; it does not merely suffocate, like water, or nitrogen, or hydrogen; but it is very much less poisonous than carbonic oxide. It has been found by experiment that an atmosphere containing only a hundreth of carbonic oxide is as fatal to a bird as one containing a twenty-fifth part of carbonic acid."—STORER AND ELLIOT: *Chemistry*, Boston, 1867, p. 334.

"When respired, even though diluted with air, it [carbonic oxide] acts as a direct poison."—MILLER, *Chemistry*, London, 1856, part 2, p. 401.

"It is very fatal to animals, and when inspired in a pure state almost immediately produces coma."—URE: *Dictionary*, London, 1863, p, 610.

"It is a very poisonous gas, acting chiefly on the nervous system, causing giddiness when inhaled, sometimes, also acute pain in various parts of the body, and after a while complete asphyxia."—WATTS: *Dictionary of Chemistry*, London, 1868, vol. 1, p. 774.

"According to the observations of M. Leblanc, carbonic oxide exercises a very deleterious action on the animal economy, even when it is breathed mixed in small proportions with atmospheric air. It is to carbonic oxide that are to be attributed the serious accidents that occur to men who are in a close room where charcoal is burned, and the air is not renewed. A few per cent. of this gas is sufficient to kill an animal that breathes the mixture in a short time."—PAYEN: *Chemie Industrielle,* Paris, 1867, vol. 1, p. 119.

"It is very poisonous. According to F. Leblanc, a bird dies instantly in air containing four to five per cent. of this gas, and one per cent. was sufficient to cause death in two minutes. The deleterious action of charcoal fumes is due principally to carbonic oxide.—WURTZ; *Dictionnaire de Chimie*, Paris, 1873, vol. 1, part 2, p. 755.

"Carbonic oxide is a very powerful poison."—SCHORLEMMER: *Kohlenstoff-Verbendungen*, Brunswick, 1871, p. 82.

"Animals die immediately in carbonic oxide gas, and some persons who tried to breathe it suddenly fell senseless to the ground."—BERZELIUS: *Lehrbuch der Chemie,* Leipsic, 1856, vol. 1, p. 643.

"Carbonic oxide not only does not support the process of respiration in animals, but it acts positively harmful as a narcotic poison. In an atmosphere which contains only a few per cent. of carbonic oxide an animal dies quickly. This gas is the principal cause of the deadly action of charcoal fumes in a close room."—GORUP-BESANEZ: *Lehrbuch der Chemie,* Brunswick, 1859, vol. 1, p. 286.

"Small animals die immediately in carbonic oxide. When breathed, it immediately produces dizziness and fainting fits." —GMELIN-KRAUT: *Handbuch der anorganischen Chemie,* Heidelberg, 1872, vol. 1, part 2, p. 72.

"Carbonic oxide not only cannot support respiration, but works as a poison on the animal organism, probably by taking oxygen from the blood."—GRAHAM-OTTO: *Lehrbuch der Chemie,* Brunswick, 1863, vol. 2, part 1, p. 1068.

"Carbonic oxide is very poisonous: small animals die quickly in the gas. Atmospheric air mixed with a little carbonic oxide produces dizziness, headache, swooning, and even death. The accidents which are caused by charcoal fumes, by the use of brasiers for heating rooms, or by closing the damper too soon, are to be ascribed to the formation of carbonic oxide. . . . When breathed carbonic oxide is absorbed by the blood cor-

puscles, and combines with them to carboxy hæmoglobin, which is easily detected by the spectroscope."—FEHLING : *Neues Handworterbuch der Chimie*, Brunswick, 1881, vol 3, p. 1051.

"The directly poisonous effect of carbonic acid, on the other hand, has been very much exaggerated. A very large quantity of pure carbonic acid (ten to fifteen or twenty per cent.) may be contained in air without producing any very serious immediate effect, if the quantity of oxygen be simultaneously increased. . . . Carbonic oxide has a much more serious effect, as it turns out the oxygen from the blood corpuscles, and forms a combination of its own with the hæmoglobin. The compound thus formed is only very gradually decomposed by fresh oxygen; so if any large proportion of the blood corpuscles be thus rendered useless, the animal dies before restoration can be effected. Badly made gas sometimes contains twenty to thirty per cent. of carbonic oxide; and, under these circumstances, a leakage of the pipes in a house may be extremely perilous to life."—HUXLEY : *Physiology*, London, 1872, p. 98.

"As has already been stated, the loosely combined oxygen, which is contained in oxyhæmoglobin, and which, at least in great part, can be driven out by a stream of indifferent gas, can be quickly displaced from this combination by carbonic oxide. By this treatment as much carbonic oxide combines with the hæmoglobin as there is oxygen displaced. The compounds of carboxy hæmoglobin crystallize in the same forms as the corresponding oxyhæmoglobins, but are rather less soluble in water, and are still more difficultly decomposed into carbonic oxide and hæmoglobin by a vacuum or a stream of indifferent gas. . . . The compound carboxy hæmoglobin is of special interest, as its behavior gives a complete explanation of the poisoning of man and animals by carbonic oxide; and its optical properties give a means of detecting this poisoning, even in portions of blood that have been kept a very long time, if they have been protected from oxygen."—HOPPE-SEYLER : *Physiologische Chemie*, Berlin, 1879, p. 383.

POISONOUS GASES.

"These can be breathed, but, when absorbed by the blood, exert a hurtful or deadly action on the organism."

He gives the following classification:

"(*a*) Reducing gases, including sulphuretted, phosphuretted, arseniuretted, and antimoniuretted hydrogen, nitric oxide, and cyanogen.

"(*b*) Gases which drive out oxygen.

"They drive oxygen out of its combination with hæmoglobin, and themselves form a stable bright red compound. They likewise give rise to the appearance due to lack of oxygen.

"1. Carbonic Oxide.

"If the blood is not completely saturated with carbonic oxide, a restoration is possible, as the oxygen still present in the blood oxydizes the carbonic oxide to carbonic acid.

"2. Nitric Oxide.

"(*c*) Intoxicating gases, including nitrous oxide, methyl chloride, and carbonic acid."—Hermann: *Physiologie*, Berlin, 1877, p. 172.

"Carbonic oxide plays a prominent part amongst poisonous gases.

"In general this poison is mixed with other, in part, indifferent gases, so that, however strongly inclined, we can scarcely regard the cases as simple cases of poisoning by carbonic oxide. Yet multiplied experiences have taught us that the danger of these mixtures depends undoubtedly on the carbonic oxide present; and that, apart from this, the gaseous mixtures produce but very trifling symptoms. We may therefore practically disregard the admixtures."—Boehm: Article Poisons. Ziemssen's *Cyclopædia of the Practice of Medicine*, New York, 1878, vol. 17, p. 456.

"Carbonic oxide . . . is one of the most poisonous gases known: its injurious action has often been exercised on man, as it is necessary to ascribe to it the largest part in cases of poisoning by charcoal fumes.

"We are then obliged to regard carbonic oxide as a violent poison of immediate action but short duration" (p. 198).

"Carburetted hydrogen is little poisonous" (p. 202).—Claude Bernard: *Lecons sur les Effets des Substances Toxique*, Paris, 1857, p. 157.

"In 1814 the two assistants of Mr. Higgins, of Dublin, made experiments with it upon themselves, and in one case—that of Mr. Wilter—with almost fatal result. Having exhausted the lungs of air, he inhaled the pure gas three or four times, and was suddenly deprived of sense and volition. He fell upon the floor, and continued in a state of perfect insensibility, resembling apoplexy, and with a pulse nearly extinct. Various restorative means were employed, but without success, until they resorted to the use of oxygen, which was forced into his lungs, and then his life was restored; but he was affected with convulsive agitation of

the body for the rest of the day. He suffered, also, from violent headache, a stupor, and a quick, irregular pulse. Even after mental recovery, he suffered from giddiness, blindness, nausea, alternate heats and chills, and irresistible sleep. The other gentleman, after inhaling the gas two or three times, was seized with giddiness, tremor, and incipient insensibility. These effects were followed by languor, weakness, and headache, of some hours' duration."

Then he refers to the experiments of Tourdes and Leblanc:—

"Very recently I have myself ascertained that air containing only five-tenths per cent. of the gas will kill small birds in three minutes, and that a mixture containing one per cent. of the gas will kill in half the time; an atmosphere having two per cent. of the gas will render a Guinea-pig insensible in two minutes; and in all these cases the effects were the same. The animals show no sign of pain; they fall insensible, and either die at once with a slight flutter, hardly amounting to convulsion, or they gradually sleep away, as if in profound coma.

"In the year 1846 M. Adrian Chenol (Chenot) was anxious to ascertain the properties of the gases yielded by his process of smelting zinc ores with carbon; and, not having a suitable instrument for collecting the gases, he attempted to draw them out of the furnace by means of a pipette. Some of the gas was thus inhaled, and he fell immediately as if he had been stunned; the eyes were turned back in the orbits; the skin was discolored; the veins were swollen, and presented a black tint under the skin; there were violent pains in the chest; and the brain was powerfully oppressed. After removal to the open air, and the application of restoratives, sensibility gradually returned; but the internal pains were still severe, and there was a feeling of suffocation. For several days he felt depressed and languid; the digestion was bad; sleep was obstinate and heavy, and it was frequently disturbed by cramps in the knees and toes. Even for months afterwards there was a morbidly excited state of the nervous system."—LETHEBY: *Lancet*, March 1, 1862, p. 219.

"Carbonic acid causes death by asphyxia, pure and simple, but it is quite otherwise with carbonic oxide." [Thinks there is a cauterization by oxidation of carbonic oxide to carbonic acid.] "It is this which causes the atrocious pain which accompanies poisoning by carbonic oxide, so different from that caused by carbonic acid. . . . Pure carbonic oxide is not only a reducing agent of the greatest energy, but a violent poison, a frightful poison even in the smallest quantity. In my own case,

a state of very poor health is the consequence of several poisonings by this gas" [the details of one of his poisonings are given by Letheby].—CHENOT: *Comptes Rendus*, vol. 38, p. 736.

[Pokrowsky describes repeated experiments on cats and dogs which were killed by pure carbonic oxide in from three to five minutes. With one-half per cent. carbonic oxide they were killed in from two to three hours. The carbonic oxide given off by the animals was absorbed by potash.]

"During these experiments, my comrades and myself thought we would breathe air mixed with carbonic oxide. Immediately (one minute) a headache set in; also a loud noise in the ears, dizziness, throbbing temples, indistinctness of vision, sleepiness, and apathy were among the sensations experienced" (p. 535).

"It follows that the enormous poisonous activity of carbonic oxide is caused only by lack of oxygen in the blood" (p. 548).—POKROWSKY: *Virchow's Archive fur pathologische Anatomie und Physiologie*, vol. 30, p. 525.

[The article is devoted chiefly to the theory of poisoning by carbonic oxide. This is the case with an article by Klebs in the same publication, vol. 32, p. 451].

[Experiments were made with a dog weighing about thirty-two pounds, who was made to breathe an atmosphere containing one per cent. of carbonic oxide. He died in twenty-two minutes; and while the normal blood of the animal contained, per one hundred cubic centimetres, twenty-two and one-tenth cubic centimetres (0 ° C., 760 m. m.) of oxygen, only eleven and four-tenths cubic centimetres of oxygen were found in his blood after death. Air containing fifty-four hundredths per cent. of carbonic oxide killed a dog in fifty-two minutes. The blood of the animal contained twenty-one and eight-tenths cubic centimetres of oxygen before breathing the mixture, while after death only six and eight-tenths cubic centimetres. A dog was exposed to atmospheres containing various amounts of carbonic oxide, and the quantity of oxygen in his blood determined before and after the experiment.]—GREHANT: *Comptes Rendus*, vol. 87, p. 194.

The results are given in the following table:—

Percentage of Carbonic Oxide.	Time of Exposure.	Oxygen in 100 c.c. of Blood.	
		Before.	After.
.2	30	24.2 c c.	14.2 c.c.
.1	70	25.5 "	15.4 "
.05	45	21.8 "	17.2 "
.025	60	21.0 "	19.9 "

"Carbonic oxide must be designated as a poison which is absorbed with especial ease by the blood through the lungs, and taken to all parts of the body. The fact is that carbonic oxide combines with the corpuscles of the blood, and sets free its own volume of oxygen."—DRAGENDORFF: *Ermittelung der Giften*, St. Petersburg, 1876, p. 78.

"According to Laurent and Thomas, an atmosphere which contains one part of carbonic oxide to twenty volumes of air occasions intoxication. Tardieu thinks even one per cent. dangerous. Experiments which Tourdes made on animals showed that three per cent. was sufficient to kill kittens in thirty-seven minutes, and that two per cent. killed doves in only three minutes. One per cent. acted on mice and small birds in two minutes; five per cent. almost instantaneously."—HUSEMANN: *Toxikologie*, Berlin, 1862, p. 645.

"Without discussing all the experiments in detail, it may be broadly stated that the addition of ten to fifteen per cent. of carbonic acid to air would render it poisonous. . . . Carbonic oxide . . . is very poisonous. . . . Carbonic oxide, when respired, passes freely into the lungs, as much as four per cent. being found in the blood of animals exposed for from ten to twenty-five seconds to an atmosphere containing ten per cent. of the gas. When absorbed by the blood, it combines with the hæmoglobin. M. Grehant points out that carbonic oxide is eliminated from the lungs (the organs through which it enters) as carbonic oxide, and may thus be distinguished from gases that undergo combustion in the organism."

[The experiments of Desormes and Clement, H. Davy, Nysten, Higgins, Tourdes, Leblanc and Dumas, and Letheby are then referred to.]

"Carbonic oxide is, in short, a pure narcotic poison. The blood after death was found redder than usual, the brain a little congested, and the auricles somewhat gorged with blood. Effusion of blood in the brain was always found in birds that had been poisoned with it.

"The large quantity of carbonic oxide (often thirty-four per cent.) in water gas would render its employment dangerous as an agent of illumination.

"In London gas the amount of carbonic oxide varies from about five to seven per cent., light carburetted hydrogen from forty to forty-five per cent. and olefiant gas from three to four per cent. There is little doubt that carbonic oxide is the most actively poisonous of the gases present. Indeed, some have stated that it is the only poisonous body (M. Tourdes). But it

is more probable, as Dr. Taylor suggests, that the various hydrocarbons present have also a noxious influence. It is curious, however, that in a very diluted state carburetted hydrogen does not appear dangerous to health, inasmuch as the miners breathe it continually without any apparent ill effects resulting" (p. 487). —WOODMAN AND TIDY: *Forensic Medicine and Toxicology*, Philadelphia, 1877, p. 482.

"But carbonic oxide gas, and still more cyanogen gas, when present, occasions in reality the injurious action of such air on the inhabitants of the apartments in question. This action first shows itself by dizziness, vomiting, stupefaction, and swooning, and at last causes death if the exposed persons are not soon carried into the fresh air, and medical help summoned. Even the amount of one-quarter per cent. carbonic oxide gas in the air gives the above hurtful action."—DUFLOS: *Handbuch der Analyse der Chemischen Gifte*, Breslau and Leip., 1873, p. 36.

"Besides, it is not the things removed by purification . . . which principally produce poisoning by illuminating gas, but it is carbonic oxide. Also Husemann and Eulenberg are of the opinion that the carbonic oxide in illuminating gas is to be regarded as *materia toxico princeps*."

"Tourdes removed the empyreumatic admixtures by treating with sulphuric acid, and found the illuminating gas just as active as before."

[He then quotes various authors, and shows that hydrogen, marsh gas, and the heavy hydrocarbons are without any decided poisonous action.]

"As we have seen, the active component of illuminating gas is carbonic oxide, and the appearances in poisoning by illuminating gas are identical with those which occur in poisoning by carbonic oxide" (p. 113).—KIRCHHOFFER: *Vergiftung durch Leuchtgas*, Herisau, 1868, p. 108.

Carbonic oxide is one of the most violent of poisons; for in an atmosphere containing only a few per cent. of carbonic oxide, animals die after a short time. In men, a very small amount mixed with air causes relaxation, headache, a choking feeling, stupefaction, and death."—BANDLIN: *Die Gifte und ihre Gegengifte*, Basel, 1869, vol. 1, p. 222.

He does not consider carburetted hydrogen or olefiant gas as particularly dangerous.

KIRKHAM'S GAS.—The use of this gas should also be severely forbidden; and to prove it your reporter need only cite the passage from the *proces-verbal* of your third sitting, in which is reproduced the opinion given before the commission by M. Dumas:

"Carbonic oxide," said M. Dumas, "is a gas known from the beginning of the present century; and for many years no one thought of attributing poisonous properties to it; no man of science suspected it. When, therefore, fifteen years ago, it was proposed to me to employ water gas for lighting and heating, I must acknowledge I did not hesitate to advise, in my course of lectures, the making of experiments in this direction.

"M. Selligue appropriated this idea, and made gas by the decomposition of water, in the works at Batignolles, and rendered it illuminating by means of schist oil. Neither M. Selligue nor any one else then knew that this gas was poisonous; that was discovered later by M. Leblanc in my laboratory; and we made some decisive experiments."

Leblanc's experiments are then described: "M. Selligue believed, with the most entire good faith, in the excellence and innocence of his process. He lighted a part of the town of Strasburg. One night the gas penetrated into a baker's shop, and several persons died. This was the first proof of the poisonous properties of this gas. Some time afterwards M. Dupuis Delcourt was desirous of making a balloon ascent, and, instead of taking hydrogen gas, he was obliged, by an accident, to take M. Selligue's gas. The balloon was inflated. In a few seconds the aeronaut fell, suffocated in his car. The balloon descended to the earth, and M. Dupuis Delcourt recovered his senses; but persons who approached the balloon to give him assistance themselves fainted and fell.

"It has since been found that carbonic oxide may be collected from blast furnaces, and constitute useful fuel; but when the workmen of the forges breathe it, they are struck, and fall. There are hundreds of this sort of accidents, always transitory, because they take place in the open air.

"It is impossible to admit that a gas producing such effects should be employed in any close apartment—in a shop, or in a theatre.

"Such is the opinion of the honorable president of the commission; and if it is considered that the gas extracted from water by the process of the 'L'Alliance' Company contains as much as thirty per cent. of carbonic oxide, we may ask, as I had the honor to observe in the last sitting, whether there is any cause to approve of experiments resulting in the manufacture of a gas containing such proportions of poisonous substances. We cannot, gentlemen, by our silence, encourage so dangerous a manufacture; and it was with great truth that one

of our colleagues said, in one of our former sittings, that notions of this nature would be usefully published, because they were not generally known.

"It must be concluded from all this, that the gas of the company 'L'Alliance' should not only not be applied to the lighting of a large city, but that even its private use should be severely forbidden."—PELOUZE and DUMAS, *Raport de M. Pelouze au Conseil Municipal de Paris, Journal of Gaslight*, London, 1854, p. 529.

"The point of departure of my researches has been the following fact: Trying to determine the action of different proportions of carbonic oxide, I have found that a certain number of animals, when in a state of apparent death, easily recovered, and could thus serve for new experiments. The two fundamental facts are the harmlessness of the gas, and its anæsthetic action analogous to chloroform and ether. An animal can be rendered senseless several times in succession, and promptly and completely recover after each experiment. This proof can be repeated during several days on the same animal without compromising his life. Animals submitted to the action of carbonic oxide are plunged in a complete anæsthesia, which can go as far as apparent death."—TOURDES: *Comtes Rendus*, vol. 44, p. 96.

But on page 97 he says:

"When the action of the gas is prolonged, the animal succumbs. It is necessary to stop before anæsthesia is complete. Death can be sudden, with cries and convulsions; more often it is quiet. The transition from sleep to death is insensible.

. . . .

"In verifying the anæsthetic action of carbonic oxide, it is a duty to make known, at the same time, the dangers which result from the gaseous form, and the difficulty of applying this agent, so as to bear no responsibility for the accidents which may happen some day."

Dr. Ozanam has also published a work on the anæsthetic action of carbonic oxide, copious extracts from which are given in an article by Professor Morton, in "The American Gaslight Journal," March 2 and 16, 1878, where may also be found a long list of quotations from scientific works; which list is in great part different from that here given. But although the authors are different, all are of the opinion that carbonic oxide is a deadly poison when breathed in any considerable quantity. To be sure, most of the authors who go into details

state that it renders persons senseless, and so is an anæsthetic; but they also state that it is doubtful whether death or recovery will occur. Where there is any expression of opinion, there is agreement that illuminating gas owes its poisonous properties mostly to carbonic oxide.

It has not been thought necessary to give an account of the numerous cases of poisoning by illuminating gas, as no account has been found giving the quantity of carbonic oxide present. The accidents usually occur by an escape of gas into sleeping apartments, and are frequently caused by blowing out the gas, or else there is a leak in the fixtures. Sometimes a street main breaks, and the gas escapes into the sewers and drains, frequently rendering several houses uninhabitable for the time. There are many of these various accidents in the aggregate, but the most of them are not fatal.

It is easily seen, that, if the escaping gas had contained a much greater percentage of carbonic oxide, there would have been a greater proportion of fatalities.

In former reports I have published twenty-one eudiometric analyses, made by myself or under my direction, of coal gas manufactured in this State. The average amount of carbonic oxide was six and fifty-two hundredths per cent., only four of the analyses showing less than five or more than eight per cent.

The mixed gases made from petroleum and water or wood contain various quantities of carbonic oxide; and perhaps twenty-five per cent. would be a fair average, or about four times as much as is present in ordinary gas.

It has also been urged that carbonic oxide is so very poisonous that it makes little difference how much is present, as the person exposed to its action is killed, whatever the quantity. A little calculation shows that this is not the fact. If gas containing six and a half per cent. of carbonic oxide is allowed to escape at the rate of five feet per hour into a close room of eight hundred cubic feet capacity, at the end of twelve hours there would be less than one-half per cent. carbonic oxide present in the room. It is somewhat doubtful whether a person could survive many hours in such an atmosphere; but there is no doubt but what he would soon die if he breathed an atmosphere containing two per cent. carbonic oxide.

But most sleeping apartments contain more than eight hundred cubic feet; and there is always some change of air even in the worst ventilated apartments, as the walls are porous, and the doors and windows do not fit perfectly even if fully closed.

If the room contained twelve hundred cubic feet, and half the gas escaped, only sixteen hundredths per cent. carbonic oxide would be present at the end of twelve hours. This quantity, although it would be harmful, would scarcely cause death; while, if sixty-four hundredths per cent. was present, there would be great danger.

It may be well to state, that, for the same amount of light, there is no great difference between the products of combustion of coal gas and the mixed petroleum and water gas; the chief products in either case, besides nitrogen, being water and carbonic acid.

Respectfully,

CHARLES W. HINMAN,

State Gas Inspector.

APPENDIX E. PAPER 17.

SOME FACTS AND CONSIDERATIONS RELATIVE TO THE GAS QUESTION IN DETROIT.

By the Detroit Gaslight Company.

An application has been made in the name of the United Gas Improvement Company, of Philadelphia, for the introduction of water gas into Detroit. It is said that Mr. Jackson, through whom the application is made, is not himself interested in the matter, but is simply employed to get ordinances passed in various cities for the benefit of operators who work behind him.

It is a curious fact that, while few, if any one, wish to invest in gas stocks; while newspapers declare that gas is retreating before electric light, the patent gaslight man is as irrepressible as ever. He is as profuse in his promises, as seductive as ever in his assurances of cheap gas. He knows that he is dealing with a matter where general knowledge is scant, and that before his promises are found to be a fraud he can be at a safe distance reaping new fields.

This time it is the "Patent Lowe Water Gas." It is to be a cheaper and better light than any other. As the light is not here and the bills not yet rendered, people are expected to take it on trust. Men are loth not to trust promises so enticing. If heard

for the first time, we should not wonder that they secured belief, but the story is an old one. Over and over again they have been repeated to credulons and over-reached communities.

One thing is plain to common sense, the promoters of this gas scheme come here to make money in some way; this can only be done in one of two ways: 1st, by making and selling gas as a business; or, 2d, by levying blackmail on the old companies, or by "shearing the lamb" with patent gas stocks and bonds.

LIMITATIONS OF COMPETITION.

The first method is out of the question, it has been tried over and over again, and always failed as a competing company. They say they have a cheaper process of making gas. This we deny. We assert that nothing ever has, or ever will in the long run, equal a good gas coal for making cheap, safe and desirable gas. Patent gases come and go, but coal gas remains. But even if the claim that they can make a cheaper gas were true it would make no difference. An existing company cannot allow its customers to be taken away, and of necessity puts down prices till neither can make money. Competition then becomes destructive and can have but one issue. After an exhaustive struggle a truce must be reached and prices advanced to a remunerative point, which now has to cover two capitals, where only one was required before. No law, no device can prevent this. It never has and it never can. The necessity of self-preservation is stronger than any promise. So numerous have been the actual proofs of this in the gas business that the argument is ended.

It is fallacy therefore to suppose that gas can be cheapened by rival companies in the same district. It is not a field in which principles of competition can be usefully applied. No one who has considered the question can doubt that here, in Detroit, gas could be sold for at least fifty cents per thousand feet cheaper, if it was all supplied through one agency.

That eminent thinker, John Stuart Mill, has pointed this out very clearly:

"When," said he, "in any employment the *regime* of independent small producers has either never been possible, or has been suspended, and the system of many work people under one management has become fully established, from that time any further enlargement in the scale of production is an unqualified benefit. It is obvious, for example, how great an economy of

labor would be obtained if London were to be supplied by a single gas or water company, instead of the existing plurality. While there are even as many as two, this implies double establishments of all sorts, when one only, with a small increase, could probably perform the whole operation equally well; double sets of machinery and works, when the whole of the gas or water required could generally be produced by one set only; even double sets of pipes, if the companies did not prevent this needless expense, by agreeing on a division of the territory.

"Were there only one establishment, it could make lower charges consistently with obtaining the rates of profit now realized.

"It is, however, an error to suppose that prices are ever permanently kept down by the competition of these companies. Where competitors are so few, they always end by agreeing not to compete. They may run the race of cheapness to ruin a new candidate, but as soon as he has established his footing, they come to terms with him. When, therefore, a business of real public importance can only be carried on advantageously upon so large a scale as to render the liberty of competition almost illusory, it is an unthrifty dispensation of the public resources that several costly sets of arrangements should be kept up for the purpose of rendering to the community the one service."

It is easy to see why a gas or water supply cannot be brought within the ordinary rule of competition. When an ordinary business is unprofitable, it can be withdrawn, or converted into something else. But the plant of a gas company is immovable and unconvertable. If a rival company seeks to divert its business, it precipitates a strife likely to be destructive to both, from which neither can escape, except by some compromise at the cost of consumers.

It has been said, and it is believed with absolute truth, "that there is not to-day, in this country, or in the world, a single legitimate competing gas company; and by legitimate is meant a company conducting its business on business principles, and earning a dividend on the capital invested."

It is almost equally true that the price of gas has never been cheapened permanently by the actual competition of a rival company; while in many cases it has been increased.

It is true there has been a gradual and steady decline in the price of gas, but this is due to improved processes, cheaper mate-

rials, and increased consumption. This last is a most important factor. The ability of any company to reduce its price of gas, depends directly on the extent of its sales.

These statements are not speculative, but rest on the best proof.

London had formerly thirteen independent gas companies. It was found that competition did not compete. The evils became so great that parliamentary legislation had to be resorted to. Under the authority of Government the thirteen companies were reduced to three, and the result has been that London is now supplied with the cheapest gas in the world.

Paris had eight companies, but by order of the Government they were consolidated into one company, and the price of gas was reduced to $1.45 per thousand feet, besides paying a very large sum into the public treasury.

In 1857, Liverpool was supplied by two companies; a third applied to Parliament for a charter to establish a competition. A careful inquiry into the whole subject led not only to a denial of the application, but to a requirement that the two existing companies should consolidate in the interest of the consumers.

New York has admitted one company after another until she now has seven. Two of the companies make water gas by the Tessie du Motay process, which they claim as the "best in the world." Several of them came in under promises as enticing as those used here, especially was this the case with the Mutual. The "New York Tribune" shall give us the result:

"The Mutual seems to have come into amicable relations with the members of the old monopoly it was created to destroy, for the bids this year have gone nearly up to the old figures of four years ago, and each company has bid for, not all the lamps in the streets in which the mains are laid, but only for those which it now lights. A reporter called upon the President, but he declined to say anything about the reasons for increasing the charges for next year, except that they had lighted the streets for nothing this year, and intended to be paid for it next year."

The upshot of all now is a common price of $2.25 all around, only twenty-five cents less than the price twenty years ago.

The New York Sanitary Engineer, of December, 1881, gives the reason thus:

"The present high price for gas in this city is very properly claimed to be due to the fact that there is too much capital invested in the business. History is repeating itself; yet, we

presume our press and people will welcome another gas company, another gas war, and then howl at another consolidation and the subsequent advance in price."

This sounds very much as if it were written for the latitude of Detroit.

Right here, it is pertinent to compare the gas history of Boston and New York. Boston has but one company. She has never permitted competing gas companies to tear up her streets. The cost of gas material is more, and the consumption of gas less in Boston than in New York, and yet to-day, the price of gas at Boston is less than in New York.

Brooklyn has also taken a hand at competition. She has six companies. She too has water gas competition. Gas has been sold as low as 12½ cents per one thousand ; but then competition reached its last term. By common consent of all the companies, old prices were restored, and so remain with an unimportant exception.

Still the patent gas man was on hand for more tribute from Brooklyn.

This is what a committee of the Board of Aldermen said :

"Instead of competing, the new companies have at once coalesced with the existing monopolies, and with appetites fresh and unsatiated they, for the most part, have even exceeded in rapacity the older cormorants. They have neither improved the quality of the gas nor manifested a disposition to reduce the cost to the consumers; and to-day the result is that, instead of two corporations preying upon the people, there are six."

The Mayor of Brooklyn put the matter thus :

"There is apparently more capital invested in the gas business here in Brooklyn than is needed to conduct it. There are more companies here than are compatible with a close and economical conducting of the business. Our city does not need more gas companies, it requires fewer."

Finally, the "Brooklyn Eagle" summed it all up in a nutshell :

"Paradoxical as the statement may appear, Brooklyn is suffering because there are too many gas companies. They owe their existence to what was termed the spirit of competition. They simply proved efficient in getting far more capital sunk in the works and mains than the demand for gas could possibly justify."

Buffalo has had two competing companies in addition to the original company, and the result now is three separate districts and a price of $2.50 all round.

Charleston, S. C., after a gas war, has a consolidation with an addition of $366,000 useless capital to earn dividends on, with gas at $2.85.

Albany had an increase of $1,000,000 capital, with two districts, and a price of $2.50. It is believed there is now a consolidation.

Providence, R. I., after a short competition, consolidated, and gas is sold at $2.10.

Trenton, N. J., took water gas, but after a short fight it sold out to the old company, and the price is $2.50.

Norwich, Ct., had competition, then consolidation, and then a price, first $3.50 and now $3.00.

At Troy, water gas competed for a short time, but it ended with two districts and a needless increase of gas capital to the amount of $700,000 in stocks and bonds, and a price of $3.00 to the consumer.

In Baltimore, the Water Gas Company consolidated with two other companies and put the price up to $2.00. A speculative coal gas company has since gone into Baltimore, a new gas war has begun, the price has been put down to $1.00, and all parties are selling gas at a loss. This time we have coal gas promising to undersell water gas.

At San Francisco there is a competing water gas company. It started with the Hanlon-Campbell process, which is one of the many water gas processes. This failed. It has now resorted to the Lowe process, but has been obliged to levy an assessment of $60,000 on its shareholders. The "Gaslight Journal" says: "The results are unsatisfactory, and the consumers are constantly complaining."

At Atlantic City, N. J., the water gas company promised gas at $1.50, they have now raised it to $2.50, to private consumers.

In Paterson, N. J., the water gas folks promised to sell at $1.50. After a fight, they leased the old works, and at once put the price up to $2.00 for large consumers and $2.25 for smaller ones.*

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*Note—Since writing the above a statement in the "Post and Tribune," April 29, 1883, that the prices in Paterson is $1.42½ has been noticed. This probably is the price to the city for use in lamps, &c., and under an old contract. The prices given in the text is on the authority of the following telegram, published by B H. Bartol, Esq., President of the Washington Gas Co., over his own signature:

"Paterson, N. J., Jan. 27, 1883. The price of gas is $2.00 to large consumers, and $2.25 to small consumers."

At Rochester, N. Y., the water gas company obtained admission under special promise to furnish cheap gas, declaring that they could sell it at $1.25. After a fight, they have compromised at a price of $2.00 all round.

At Philadelphia, in 1875, a water gas company offered to furnish their water gas in the holders of the city ready to be sent out to customers at $1.00 per thousand. The offer was accepted, but after a year's trial, there was so great and general dissatisfaction among consumers, that the trustees of the City Gas Works terminated the contract and returned to the use of coal gas.

At Indianapolis, Ind., the competition has ended as usual. Both companies are now owned in the same interest, and water gas is only used on special occasions when the supply of coal gas is short. Price, $2.00.

In Washington, the old company, under threats of competition was induced to buy the patents and adopt the "Lowe Process," yet the officers of that company openly declare that the results are not satisfactory; that the product is but little over half the guaranteed quantity, and that it is more costly than coal gas.

In Toronto, Can., the water gas men took possession with special demonstration. They got possession of the old coal gas works and substituted the Lowe apparatus. Of their history at Toronto, a distinguished citizen of the Dominion, in a letter now before us, writes as follows:

"Their difficulties and troubles with the public has been about proportionate to the amount of water gas they were supplying. When they were making the whole of their consumption of water gas, their troubles and the howl of public dissatisfaction was at its height. Public feeling was such that inasmuch as six or eight deaths has been caused in hotels and private houses by escapes of that gas since its introduction about four years ago, and a number of cases of partial suffocation, the City Council petitioned the Dominion Parliament to institute an inquiry. This has not yet been done. * * * They last year went back partially to coal gas, making the excuse that their Lowe plant would not make enough for them.

Other instances might be cited, but this is enough. It proves decisively that no money is made by gas companies selling gas in competition, and where competing works are actually built, the result is some scheme by which competition ceases.

HOW THE LAMBS ARE "SHEARED" AND THE MONEY MADE.

It is of very little consequence that no money can be made by selling gas in competition. These "improvement" companies have "improved" a device that makes them all right. They launch new companies by that consummate contrivance of modern finance—stock and bonds. The patent-gas man always contrives to unload his stocks and bonds on to credulous investors before the bottom drops out. In Newark, N. J., the competing company never earned a dollar, yet it declared a dividend of $51,225, and thereby enabled the original parties to unload; this is a regular system. Construction companies send agents out to get ordinances passed, they then get up a local corporation, and if they can find local dupes to subscribe for part of its stock, so much the better, that secures so much cash; stock and bonds are provided liberally for the rest. An interior ring takes the contract for the building of the works, to be paid at least two prices in stock and bonds. It only remains to unload the stock and bonds and "the lambs are sheared."

Thus, in Rochester, after the water gas works were completed in 1881, a careful appraisal showed the entire works worth not over $300,000. Yet at this time the official report showed that some one had swallowed up full paid stock:

Stock	$500,000
Bonds	200,000
Total	$700,000

It is no wonder that the secretary and treasurer at that time declared, under oath, that the stock was worth only thirty cents on the dollar. In fact it then had no market value whatever.

The works of the water gas company of San Francisco, as originally built, were, upon a careful valuation, estimated as worth only $131,000. Now, just here, was seen the hand of the enterprising gas contractor. A Mr. Condict got up the company; the company then contracted with Mr. Condict to build the works and furnish the patents for $149,000 gold, and $400,000 stock. The account then stood thus:

Gold	$149,000
Stock	400,000
Cost of works and patents	$549,000
Value of works	131,000
Surplus for Mr. Contractor	$418,000

The United States Gas Improvement Company and the United Gas Improvement Company, are both really construction companies. They do not intend to make a business of making and selling gas. Their business is to get ordinances passed, to organize local companies, to sell them patents and to build works as contractors.

If the Council should grant their petition here, their proceeding would probably be something like this: They would organize a gas corporation under the laws of this State; get some of the stock taken here, if possible; provide for the issue of, perhaps, $1,000,000 of stock and $1,000,000 of bonds, then let the contract to the improvement company, or a ring within that company, for the building of the works, payable in stock and bonds. After the works were built their cash value would be found not to exceed one-fourth or one-third the stocks and bonds which had got into the hands of the contractors. After these had been improved into the hands of third parties, it would be found that the gas business would not carry such a load; a foreclosure would follow, the stock would be wiped out, and the bondholders would find the works on their hands worth only a fraction of the face of their bonds. All the money made in the transaction would be found in the pockets of the Improvement Company or of the ring that took the contract.

WHAT IS WATER GAS?

It is no novelty. It has been known to chemists nearly a hundred years. For nearly fifty years strenuous attempts have been made to use it as an illuminating gas. A patent was taken out as long ago as 1830. Water gas works were built near Paris in 1846. Over one hundred patents have been taken out in this country, and works were established at Philadelphia many years ago, for the production of water gas. The two methods most in use now in this country are the French process of Tessie du Motay and the Lowe Process. In general terms this last process is the passing of steam through incandescent coal (usually anthracite), and then mixing the product in hot retorts with light hydrocarbon vapors, as naphtha, benzine, etc.

These patents have been and are freely offered for sale. Gas companies are eager to find new methods which will really cheapen the cost of gas. Some large companies keep experts for that purpose. Yet out of about 800 gas companies in the United States, there are probably not over a half dozen first-

class companies that have adopted any process of water gas. This fact indicates the judgment of practical gas men of the value of this process.

The peculiar element of water gas is carbonic oxide. All good water gas contains from 20 to 30 per cent. of this oxide. It is a combustible element and is what gives the special illuminating powers to water gas.

The following table shows an analysis of coal gas and water gas:

Coal Gas.		Water Gas, (Municipal Co., N. Y.)	
Hydrogen	42.47	Hydrogen	38.20
Carbonic Oxide	2.08	Carbonic Oxide	27.14
Marsh Gas	46.16	Marsh Gas	15.82
Illuminants	6.67	Illuminants	15.29
Air	2.62	Nitrogen and Oxygen	3.45
		Carbonic Acid	.10
	100.00		100.00

Or over thirteen times as much carbonic oxide in the latter as in the former.

CARBONIC OXIDE IS A DEADLY POISON.

Of this there is no doubt. Science and facts agree as to this. Books of chemistry speak in most positive terms.

Carbonic oxide is a gas of so positive a character that, according to Leblanc, one volume of it diffused in 100 volumes of air wholly unfits it to sustain life.—Bloxam's Chemistry, p. 76.

It is not merely passive in not supporting respiration, but is active as a poison.—Regnault's Chemistry, p. 321.

Carbonic oxide is a powerful narcotic poison.—Brand & Taylor's Chemistry, p. 245.

Carbonic oxide is extremely poisonous.—Towne's Chemistry, p. 168.

Prof. Ad. Wurtz says: Not only can it suffocate, it poisons.

Many more might be cited, but they are all one way. But water gas men produce many certificates to the effect that if their gas is properly used it is quite safe. That is, if it is kept in the pipes or is burned up when it escapes and is not breathed, it is safe. This is quite true, but there is just where the shoe pinches. Gas will not always stay in the pipes. It will get out unexpectedly, by accident or negligence, in places where human beings must breathe it, and when they do breathe it, even for a little while, it is death. Other illuminating gas may asphyxiate (that is, suppress respiration and produce unconsciousness,) but does not kill. Carbonic oxide poisons the blood. A list of

persons poisoned by water gas, carefully compiled from New York papers, with name and date, shows eighty-two cases of poisoning from water gas, from October, 1878 to the close of last year, in the cities of New York and Brooklyn alone, of which fifty were fatal. Three more cases have recently occurred, all fatal, two in New York and one in Brooklyn. Six fatal cases are reported from Toronto. The city authorities of Brooklyn, alarmed by these facts have, within a few weeks past, ordered an investigation of the whole matter of gas poisoning. The above table effectually settles the whole matter. Where there is no water gas, there may be cases of asphyxiation, but no deaths. Thus in Detroit, where gas has been used for over twenty years there has never been a case of fatal gas poisoning.

As water gas is heavier than air, it falls down, and is therefore still more dangerous in sleeping rooms.

On account of its poisonous character, this gas was long ago forbidden in Paris; and in Massachusetts it is a penal offence to sell gas containing more than ten per cent of carbonic oxide.—Greenough's Digest, p. 214.

MERITS OF WATER GAS.

All patent nostrums are excessively puffed of course. It is claimed that its illuminating power is greater than that of coal gas. High candle power is given to gas by enriching with the vapors of the light hydrocarbons. This is just as easily done with coal gas as with water gas. In fact the Detroit Gaslight Company, for a considerable time, delivered gas of twenty-two candle power. The trouble about such gas is that it is not desirable to the consumers. In ordinary burners the combustion is imperfect, and smoke is produced to the injury of pictures, hangings, &c. But the very claim of water gas to superior candle power is delusive. Aa a fact, we assert that it has been found in practice impossible to maintain this gas at any uniform candle power. The lava tip is believed to be the best burner ever made, yet water gas cannot use this tip.

The claim that it is a cheaper gas is also delusive.

A glance at the list of towns where it is used, shows that a very large number are in or near the anthracite regions, where the materials used are much cheaper than elsewhere.

In the next place it will be found that a considerable number of the places given in their list, are places where the gas is made from petroleum, &c. Thus at Gt. Barrington and Southbridge, Mass., the gas is made from oil. Mr. Jackson cites these places to show the superior candle power of water gas.

Finally an examination will show that in no place is water gas sold lower than coal gas; in most places its price is higher, and in a table now before us, the average price of 446 companies using coal gas, is \$2.78 per thousand, while the average price of 120 companies making gas by some patent process, including the water gas, is \$3.73½ per thousand feet.

It will be useful to note the prices of patent gas in the following places.

Carlisle,	Penn		\$2 50
Columbia,	"		3 00
Catasqua,	"		2 50
Bethlehem,	"		2 37
Harrisburg,	"		2 00
Pittston,	"		3 00
Scranton,	"		2 25
Shippenburg,	"		2 50
Wilkesbarre,	"		2 50
Clyde, N. Y.			3 00
Newburgh,	N. Y		2 25
Port Jarvis,	"	2 50 to	3 00
Saratoga,	"	2 50 to	3 50
Yonkers,	"	2 00 to	2 50
N. Y. City	"		2 50
Burlington,	Vt.		3 00
Rutland,	"		3 00
Middletown, Conn			2 50
Sterling,	Ill.		2 80
Pullman,	"		2 25
Milford,	Del		3 50
Keene,	N. H		3 50
N. Brunswick, N. J			2 50
Atlantic City,	"		2 50

It will be seen that these are not below the usual prices of coal gas. It is plain that if water gas can be made and sold as cheaply as claimed, some of the above prices are extortionate.

Another thing should be borne in mind. The making of gas and putting it into the holder is only the smaller part of the cost to the consumer. The cost of distribution is the same whatever the kind of gas.

STREETS.

A new gas company means new lines of pipes. The streets must be torn up to lay and repair them. They must take a level

either above or below the existing gas and water pipes. The climate here will probably not permit them to go above. To go below is to disturb the security of every pipe they undermine. A pavement once broken into can never be quite restored. Now the aggregate of all these mischiefs will impose a loss on the community greater than all possible benefits from water gas.

DELUSIVE PROMISES.

The Improvement Company seeks to secure an entrance into the city by profuse and specious promises. Of course it agrees to sell gas somewhat below existing prices in some respects. This it must do to secure a hearing. But its offer to light and care for lamps at $25 each per year is one that the existing companies would be glad to make. Its promise not to sell or assign franchises is simply illusory. No corporation can sell its franchises or consolidate with another, except by leave of the Legislature, and no such power has ever been granted here to gas companies. Its proposition to lay pipe throughout the city wherever "the interest, comfort and convenience of the inhabitants" require is made ignorantly or recklessly. It would be required wherever there was one householder able to pay for gas. It is equivalent to an agreement to pipe the entire territory of the city. Such an obligation would bankrupt any company. And it may be assumed that such a promise is not made to be kept.

The above are the principal promises made by Mr. Jackson in his petition to the Council. But in his printed pamphlet he assumes to give some figures of the amount of money paid for gas consumed yearly in Detroit. He says "the people of Detroit pay for gas, public and private, the sum of $800.000 per year, which is in round numbers $300.000 in excess of what they would pay if all the gas used were furnished by our company and made by our process."

We have before spoken of the utter unreliableness of the statements and assertions made by water gas men This last one is in keeping with the rest. Eight hundred thousand dollars paid yearly in Detroit for gas, of which three hundred thousand would be saved by patent gas!

What will be the thought, when the fact is stated that there is not the slightest foundation for the above statement! The entire amount paid in this city during the last year for gas, both public and private, falls considerably below $400,000. Mr. Jackson's astonishing saving of $300,000 is pure humbug.

It is boasted that the men in the "Improvement Company" are very rich. This may be; but we have seen what their real business is, They are not here on a charitable mission to sell cheap gas. They are here to build works at extravagant prices, and to carry the booty away in fraudulent stocks and bonds.

It is even said that the Standard Oil Company is in the improvement scheme. It may be so; but if there is a merciless and unscrupulous monoply in the country it is the Standard Oil Company. It already levies its tribute in every household where a lamp is burned. Is not that enough?

CONCLUSION.

In conclusion, the Detroit Gaslight Company desire to say that its policy is to sell gas at prices which will secure only a fair profit. Circumstances beyond its control has hitherto greatly crippled it in this respect. The recent growth of the city has improved its opportunities, and before this new competition had appeared the Board of Directors had under consideration the question of a reduction of rates.

This company does not profess that it can give away gas, or that it is willing to sell it at rates that will not bring it a reasonable profit.

But a large part of its stock is held here; it is managed by directors living here; it is managed with careful economy, It knows it can furnish gas of standard quality as cheap as any honest company can, and it intends te do so. It is one of the largest taxpayers of the city, and it believes that its property will not be wantonly sacrificed that foreign speculators may be enriched.

ALEX LEWIS,
President.

GEO. V. N. LOTHROP,	J. S. FARRAND,
JOHN A. BROWN, JR.,	JEROME CROUL,
B. VERNOR,	W. J. CHITTENDEN.

Directors, Detroit Gaslight Company.

DETROIT, May 1, 1883.

APPENDIX E. PAPER 18.

Two pamphlets have been printed by opposed interests in the gas controversy, bearing the following titles :

1. " Water Gas, a Dangerous Poison," and,

2. "Have you seen their Scarecrow! Water Gas, a Dangerous Poison. Yes. To Coal Gas Companies. Why? It beats their light! It takes the business."

Inasmuch as the first is reproduced in full in the second pamphlet with running comments, the second alone will be here published : the contents of the first pamphlet appear here in quotation, in small pica type, while the comments of the second pamphlet are printed in brevier type. (See Appendix E. Paper 20.)

APPENDIX E, PAPER 19.

WATER GAS PROVED A DEADLY POISON.

The following editorial appears in the "Telegram" of November 14th, concerning the recent deaths by illuminating gas :

TURN OUT THE GAS.

"If any statistics have been taken in regard to the number of persons who have died during the year in consequence of blowing out the gas in their bedrooms, instead of turning it off, it would be interesting to know the proportion of deaths thus caused. Two more deaths from this cause have just happened at a small hotel in this city."

The attention of the writer having been called to the alarming increase of mortality in the cities of New York and Brooklyn, induced him to investigate the matter, and to ascertain, if possible, why it is that, since the introduction of gas as an artificial light—more than seventy years ago—up to within three or four years, a death from its use was an event almost unheard of, whereas within the past five years there should have occurred over eighty-three cases of suffocation and death in the cities of New York and Brooklyn alone. And why at the present time hardly a day passes that the daily papers are not called upon to record the death of some person from the use of this highly important and previously supposed harmless agent.

To all facts there are laws, and a careful and sustained investigation has convinced the writer that he has discovered

the cause of the accidents, and also warrants the suggestion by him of a remedy. So that what the writer has discovered may be clear to all, it is necessary to start at the beginning and look somewhat into the records.

For the information of those interested in this question of life and death will be briefly given—

1. The history of the production of water gas up to the year 1878.
2. The opinions of eminent and recognized authorities as to the danger of distributing such a deadly gas among consumers, ignorant of their peril.
3. The actions and opinions of those instrumental in introducing water gas into the city of New York, regarding its danger.
4. The confirmation of the deadly effects of illuminating water gas, as evinced by the records of past accidents.

The public press claim to have the best interest of the public at heart: they can by an unbiased investigation and publication of the facts, not only stop a wrong that has existed too long, but also prevent the intended increase of the evil.

The facts are given—take the list of deaths and verify or disprove the following statement:

That since 1878 eighty-three deaths, or poisonous accidents, some of the latter fatal, have been caused directly by the inhalation of illuminating water gas in New York and Brooklyn, and that but one (and he a suicide who inhaled gas for thirty-six hours in a small room, the crevices and keyhole of which he had stuffed with paper) was caused by illuminating coal gas, and this notwithstanding the fact that from four to five times more coal gas has been sold in the two cities than water gas. If it had all been water gas there would probably have been at least two hundred deaths and three hundred serious accidents in addition.

THE HISTORY OF THE PRODUCTION OF WATER GAS.

1. Water decomposed by means of incandescent carbon in the year 1793, by Lavoisier.

This subject also engaged the attention of Priestly, Cavendish and Black.

2. Donovan takes out a patent October 6, 1830.
3. Jobard, of Brussels, 1832, impregnating water gas with hydro-carbon vapors.
4. Selligue engaged in water gas researches in 1833.

5. Patents taken out by Montauban, in 1838, for producing water gas.
6. Edward Manby, patent taken out in 1839.
7. Val Marino, patents taken out in 1839.
8. Alex. Cruikshank, patents taken out in 1839.
9. Radley takes out a patent in 1845.
10. James Murdock, patent taken out in 1845.
11. Gillard establishes Water Gas Works at Passy, near Paris, in 1846.
12. Stephen White takes out a patent in 1847.
13. A. A. Croll takes out patent in 1848.
14. Webster takes out patent, 1850.
15. John and Thomas Neshan, Kirkham, take out patents, 1852, which cover, virtually, the methods in use to-day, known as the Tessie du Motay and Lowe.
16. Selligue's process has given rise to White's, Le Prince's, Isoard's, Baldam and Gune's, Kirkham's, Longbottom and Wiederhoet's processes.

Great attention was given by all interested in the gas industry to the subject of water gas from 1845 to 1856, and many experiments were made and much money expended in its production, but it was soon found to be too dangerous for distribution and was abandoned after the scientific examinations made in Paris, in 1856, where the gas was condemned and its use forbidden on account of its poisonous properties.

In the "Journal of Gas Lighting," June 10, 1856, page 334, will be found the following:

EXTINCTION OF WATER GAS.

"The manufacture of gas by the decomposition of water was to be the grand source of wealth; and the process of M. Kirkham for effecting the decomposition by incandescent coke in closed furnaces was the main reliance."

"The proceedings of the company, however, received a check in limine, because the gas produced was so highly poisonous that the public authorities prohibited its use."

To confirm this, is now given the report of M. Pelouze:

Report of M. Pelouse to the Municipal Council of Paris, in the sittings of June 24 and 28, 1854.

KIRKHAM'S REPORT.

"The use of this gas should also be severely forbidden and, to prove it, your reporter need only to cite the passage from the

proces-verbal of your third sitting, in which is reproduced the opinion emitted before the commission by M. Dumas, the distinguished professor of chemistry and member of the French Institute.

"'The oxide of carbon,' said M. Dumas, 'is a gas known from the commencement of the present century, and for many years no one thought of attributing venomous properties to it; no man of science suspected it. When, therefore, fifteen years since, it was proposed to me to employ water gas for lighting and heating, I must acknowledge I did not hesitate to advise, in my course of lectures, the making of experiments in this direction. M. Selligue appropriated to himself this idea, and made gas by the decomposition of water in the works at Batignolles, and rendered it luminiferous by means of oil of schist. Neither M. Selligue nor any one else then knew that this gas was poisonous; that was discovered later by M. Leblanc, in my laboratory, and we made some decisive experiments.

"'It was proved that a mixture of one per cent. of oxide of carbon killed a strong dog in a minute and a half; it was a case of poisoning. With one per cent. of oxide of carbon all animals died at the end of a few minutes. These experiments terrified me. Since then they have been repeated many times by different men of science. Carbonic acid must not be confounded with oxide of carbon. In the course of the experiments of which I have just spoken I formed an artificial atmosphere with 30 per cent. of carbonic acid. A large dog on being placed in it, almost immediately fell on his side, but recovered himself on being restored to the pure air. Thirty per cent. of carbonic acid did not kill; but, on the contrary, one per cent. of oxide of carbon is mortal. I am, therefore, satisfied that this oxide has the greatest inconvenience—above all when applied to lighting.

"'M. Selligue believed, with the most entire good faith, in the excellence and in the harmlessness of its process. He lighted a part of the town of Strasburg. One night the gas penetrated into a baker's shop and several persons died. This was the first proof of the poisonous properties of this gas. Some time afterwards, M. Dupuis Delcourt was desirous of making a balloon ascent, and instead of taking hydrogen gas, he was obliged by accident to employ the gas of M. Selligue. The balloon was inflated; at the end of some seconds the aeronaut fell suffocated in his car. The balloon descended to the earth, and M. Dupuis Delcourt recovered his senses, but the persons who approached the balloon to give him assistance themselves fainted and fell.

"'It has been since found that the oxide of carbon of blast furnaces may be collected and constitute useful fuel; but when the workmen at the forges breathe it they are struck and fall. There are hundreds of examples of this sort of accidents, always transitory, because they take place in the open air.

"'It is impossible to admit that gas producing such effects should be employed in any close apartment, in a shop or in theatres.'

"Such is the opinion of the honorable president of the commission, and, if it is considered that gas extracted from water by the process of the company, 'l'Alliance,' contains as much as thirty per cent. of oxide of carbon, we may ask, as I had the honor to observe in the last sitting, whether there is any cause to approve of experiments resulting in the manufacture of a gas containing such a proportion of poisonous substances?

"We cannot, gentlemen, by our silence, encourage so dangerous a manufacture; and it was with great truth that one of our colleagues said in one of our preceding sittings that notions of this nature would be very usefully published, because they are not generally known.

"It must be concluded from all this that the gas of the company 'l'Alliance,' should not only not be applied to the lighting of a large city, but that even its private use should be severely forbidden."

Since the extinction of illuminating water gas in Europe in 1856 comparatively nothing has been done there to revive its production, as it is well known there that the distribution of such a gas would be promptly suppressed.

Efforts have, however, been made to extend its use in the United States, beginning in 1865, but not much was accomplished until the advent of M. Tessie du Motay, the eminent French chemist, in 1872, when its production was begun simply in an experimental way. Not until 1877 and 1878 was its production increased and the gas distributed to consumers on a considerable scale.

The London "Journal of Gaslighting" in an article on water gas, May 28, 1878, comments on the abandonment of its manufacture in Europe on account of its poisonous properties, and referring to the above report of M. Pelouze appositely remarks of M. Tessie du Motay:

"After reading the report, we can understand why Kirkham's process was so unceremoniously abandoned in France at that time, and why in these days a Frenchman should take the idea to America instead of trying it at home."

The death of a consumer caused by the accidental inhalation of ordinary illuminating gas made from bituminous coal,

is an almost unknown occurrence. The history of coal gas illumination in the city of New York from the year of its introduction in 1823 up to 1878, a period of fifty-five years, does not, as far as can be ascertained, show a single case, and the same is true of all the neighboring cities, and, indeed, of the other large cities in the United States, as far as heard from.

But as soon as water gas begins to be distributed the startling record of deaths by gas commences, and on November 8, 1878, John Brown and Elizabeth Williams were killed by water gas at No 31 Bowery.—*N. Y. World*, November 8, 1878.

IT IS PROPER TO INQUIRE HERE AS CONFIRMATORY OF AUTHORITIES QUOTED ABOVE, WHY IS WATER GAS SO POISONOUS?

Prof. Henry Morton says in an article to the "American Gaslight Journal," March 2, 1878: "In reply to questions put to me some time since on this subject I stated that carbonic oxide, according to the opinion of the standard writers, was a virulent poison, and therefore that this gas was a very objectionable constituent in any mixture which was to be distributed for illuminating or other purposes."

Now if we take the analyses of coal and water gas and discover in one a greater proportion of carbonic oxide than the other, then it follows that the gas containing the larger proportion of carbonic oxide is the more dangerous to distribute.

So there may be no question as to the reliability of the analyses those are taken that were both made by the same chemist, and he, at the time of the analyses, a strong advocate of water gas. When he made the coal gas analysis at New Haven, February, 1869, (see report on the hydrocarbon gas process by B. Silliman and H. Wurtz, page 92), he was consulting chemist on the Gwynne Harris Water Gas Process, and was subsequently engaged on the Lowe Water Gas Process and the Tessie du Motay Water Gas Process.

Analysis of coal gas—New Haven, February 11, 1869—and water gas, Municipal Gaslight Company, New York. March 4, 1878, made by Prof. Henry Wurtz, Ph.D.

COAL GAS.		WATER GAS.	
Hydrogen	42·47	Hydrogen	38·20
Carbonic oxide	2·08	Carbonic oxide	27·14
Marsh gas	46·16	Marsh gas	15·82
Illuminants	6·67	Illuminants	15·29
Air	2·62	Nitrogen and oxygen	3·45
		Carbonic acid	·10
	100·00		100·00

It is seen by the above that water gas contains over thirteen times as much carbonic oxide (a rank poison) as coal gas, and must be at least thirteen times more dangerous to use, but experience seems to warrant the assertion that the proportion is in practice at least 160 to 1.

In other words—water gas is at least 160 times more dangerous to distribute than coal gas, or a gas containing from 2 to 6 per cent. of carbonic oxide.

THE OPINIONS OF EMINENT AND RECOGNIZED AUTHORITIES AS TO THE DANGER OF DISTRIBUTING SUCH A DEADLY GAS.

In March, 1878, Prof. Henry Morton predicted the danger and used his influence against the distribution of water gas. This it will be noted was before the occurrence of a death in this country from this source.

Carbonic oxide is the dangerous gas, existing in water gas to the extent of 25 to 30 per cent., and to show its properties we quote from an article by Professor Morton:

CARBONIC OXIDE.

IS IT A HARMLESS ANÆSTHETIC OR A VIRULENT POISON?

[By Henry Morton, Ph. D., President of the Stevens Institute of Technology.]

In reply to questions put to me on the subject some time since, I stated that carbonic oxide, according to the opinion of the standard writers, was undoubtedly a virulent poison; and, therefore, that this gas was a very objectionable constituent in any mixture which was to be distributed for illuminating or other purposes.

Since the publication of this statement of mine, I have noticed that there have been published in various journals, or printed and circulated, various statements which more or less indirectly, seem to call in question the soundness of my views on this subject.

As, after all, this is simply a question of fact, on which any one, with data before him, is competent to form a judgment, I have thought it worth while to compile all the statements by standard authors which were within my reach, and so let them speak for themselves. Whether or not such a gas as will be there found described, should be considered a virulent poison, and would be objectionable, may then be left to the reader for decision, with common sense for a sufficient guide.

Following a general chronological order in the succession of quotations, I find as follows:

Gorhaus' Chemistry, 1819, vol. i., p. 380, under the heading carbonic oxide: "It is incapable of supporting combustion, and it is fatal to animal life."

Sir Humphrey Davy once took three inspirations of it, mixed with one-fourth of common air; the effect was a temporary loss of sensation which was succeeded by giddiness, sickness and acute pains in different parts of the body, and extreme debility. Some days elapsed before he entirely recovered.

Thompson's Chemistry, London, 1831, vol. i, p. 168, under "Carbonic Oxide": "No animal can breathe it; when the attempt is made one or two inhalations occasion asphyxia. All gases containing carbon have been found positively injurious when drawn into the lungs."

Regnault's Chemistry, Philadelphia, 1852, vol. i, p. 321: "Oxide of carbon is not merely passive in not supporting respiration, but is active as a poison."

Chenot (article in the "Comptes Rendus" of the French Academy, 1854, p. 735) on pure carbonic oxide considered as a poison.

In this article the author describes the action of carbonic oxide in such terms as the following:

"The pure carbonic oxide is not simply a reducing agent of the greatest energy, but a frightful poison *(un poison fruydryant)* in any small doses. "Finally it appears that poison by carbonic oxide is the most terrible in itself, and brings after it profound disorganization."

The author spoke from his own experience, having suffered several times very seriously from accidental inhalations of small quantities of this gas. In a continuation of this subject at a subsequent date (see p. 830 of the same vol.), M. Chenot relates a number of facts which had been brought to his notice, illustrating the dangerous properties of carbonic oxide even when mingled with air.

"Chemical News" (article by H. Letheby, Professor of Chemistry and Toxicology in the Medical College of the London Hospital, April 19, 1862, p. 212): "Carbonic oxide was discovered by Priestly long before the close of the last century, and in 1802 Clement and Desormes, at the instance of Guyton Morveau, undertook a careful examination of its properties. They not only proved its chemical nature, but they also ascertained that it was a poisonous gas. Birds put into it dropped dead before they could be taken out, and when the experimenters themselves attempted to breathe it they were attacked with giddiness and faintness.* ·

* The original article by Desormes and Clement will be found in the "Annales de Chemie," vol. xxxix, p. 26. The passage here quoted is on page 56.

"Later still, in 1814, two assistants of Mr. Higgins, of Dublin, made experiments with it upon themselves, and in one case, that of Mr. Wilter, with almost fatal result. Having exhausted the lungs of air, he inhaled the pure gas three or four times, and was suddenly deprived of sense and volition; he fell upon the floor and continued in a state of perfect insensibility resembling apoplexy, and with pulse nearly extinct. Various restorative means were employed, but without success, until they resorted to the use of oxygen, which was forced into his lungs, and then his life was restored, but he was affected with violent convulsive agitations of the body the rest of the day. He suffered also from violent headache, stupor, and a quick, irregular pulse. Even after mental recovery he suffered from giddiness, blindness, nausea, alternate heats and chills, and irresistible sleep. The other gentleman, after inhaling the gas two or three times, was seized with giddiness, tremor, and incipient insensibility. These effects were followed by languor, weakness, and headache of some hours' duration. Since those experiments were made, others of a more extended character were instituted by Fourdes and by Leblanc. Fourdes found that rabbits were killed in seven minutes when they were put into a mixture of one part of the gas with seven of atmospheric air. A fifteenth part of gas in common air killed them in twenty-three minutes, and a thirtieth (30th) part in thirty-seven minutes. Leblanc's experiments were made in conjunction with Dumas, and he ascertained that one per cent. of the gas in atmospheric air would kill a small dog in a minute and a half, and that birds were killed immediately in a mixture containing five per cent. of it. Very recently I have myself ascertained that air containing only 0.5 per cent. of the gas will kill small birds in about three minutes, and that a mixture containing one per cent. of the gas will kill in about half this time. An atmosphere having two per cent. of the gas will render a guinea pig insensible in two minutes, and in all these cases the effects are the same. The animals show no sign of pain; they fall insensible, and either die at once with a slight flutter—hardly amounting to convulsions, or they gradually sleep away in a profound coma.

"Accident has also demonstrated how injurious the gas is even to a human subject. For many years past attempts have been made to promote the use of water gas as an agent of illumination. The gas sometimes contains as much as thirty-four per cent. carbonic oxide.

"It is obtained by passing steam over red-hot charcoal, and as the steam is decomposed by the ignited carbon the hydrogen is set free, and carbonic oxide with carbonic acid is produced. Patents for this process of manufacturing gas date as far back as 1810, and they have at various times been put into operation in this country, and on the continent. Selligue in 1840 obtained permission to use the gas in the towns of Dijon, Strasburg, Antwerp, and two of the faubourgs of Paris and Lyons. At Strasburg an accident occurred which put a stop to its use. The gas escaped from the pipes into a baker's shop, and was fatal to several persons; not long after an aeronaut named Delcourt incautiously used the gas for inflating his balloon. He was made insensible in the car, and those who approached the balloon to give him assistance fainted and fell likewise. The use of the gas, therefore, has been interdicted on the continent."

Bloxam's Chemistry, London, 1860, p. 78. "Carbonic oxide is a gas of so poisonous a character that, according to Leblanc, one volume of it diffused through 100 volumes of air totally unfits it to sustain life, and it appears that the lamentable accidents which too frequently occur from burning charcoal or coke in brasiers and chafing dishes, in close rooms, result from the poisonous effects of the small quantity of carbonic oxide which is produced and escapes combustion, since the amount of carbonic acid thus diffused through the air is not sufficient in many cases to account for the fatal results."

Dufla's Handbuch der angawandten Chemie, Leipzig, 1873, p. 36. "A contents of one-fourth per cent of carbonic oxide in air gives it the above mentioned injurious action (dizziness, vomiting, fainting and, finally death), and even with a much smaller amount in a prolonged exposure to such an atmosphere health may be very seriously endangered."

Bernard: "Le cons sur les effets des substances toxiques" (Paris, 1856), this author says: "Carbonic oxide is one of the most poisonous gases known."

Eliot & Storer's Chemistry, New York, 1871, p. 338, under carbonic oxide. "It extinguishes combustion just as hydrogen does, and destroys animal life. Unlike hydrogen and nitrogen, however, it is a true poison. It destroys life, not negatively by mere suffocation or exclusion of oxygen; but by direct noxious action. Even when largely diluted with air it is still poisonous, producing giddiness, insensibility and, finally death. It is the presence of this gas which occasions the peculiar sense of

oppression and headache which is experienced in rooms in which the products of combustion have escaped from fires of charcoal and anthracite. Carbonic oxide is very much more poisonous then carbonic acid. Much of the ill repute which attaches to carbonic acid really belongs to carbonic oxide ; for since both these gases are produced by burning charcoal, many persons are liable to confound them ; but carbonic acid is, comparatively speaking, almost innocuous. Carbonic acid, it is true, is somewhat poisonous ; it does not suffocate like water or nitrogen or hydrogen, but it is very much less poisonous than carbonic oxide. It has been found by experiment that an atmosphere containing only one one hundredth of carbonic oxide is as fatal to a bird as one containing one-twenty-fifth part of carbonic acid.

In the Annales de Chemie et de Physique, 1842, third series, vol. v., pp. 223–68, we find a long article by M. F. Leblanc under this title.

In this extensive treatise, covering 45 pages, the author, after describing experiments in which it was proved that the actual products of the combustion of a candle or of charcoal were far more poisonous than pure carbonic acid mingled with air, continues as follows :

"Although the opinion generally received did not appear to attribute to carbonic oxide, especially when present in small quantity, a deleterious action on the animal economy, I wished to ascertain by precise experiments the part of the influence it could exercise in the effects of the combustion of charcoal. I studied at the same time the action of the gases proto and bicarburetted hydrogen.

"Regarding these latter products, experiments show that they cannot have an active part in the asphyxiating effects of charcoal. The gas proto-carburetted hydrogen obtained from acetates and olefiant gas, can be mixed with air in the proportion of one to two hundredths without causing any apparent accidents, even at the end of a considerable time. Such is not the case with carbonic oxide. A dose of four to five parts in a hundred of air caused the instant death of a sparrow. A hundredth part of this gas mixed with air killed a bird at the end of two minutes.

"If the animal is immediately removed from this deleterious influence at the moment of apparent death, it can little by little regain life ; but it is often only after some hours that the phenomena of paralyzation disappear.

"We must, therefore, look upon carbonic oxide as a gas eminently deleterious, contrary to the conclusions of Nysten, who had placed this compound among the simply irrespirable gases. This latter opinion, besides, has not been adopted by M. Devergie in his new Traité de Médicine Légale and in his excellent article on the gases. (Dictionnaire de Médicine et de Chirurgie pratiques.) Observing that the injection of carbonic oxide into the veins, according to Nysten's experiments, caused the animals to utter cries of pain, and relying moreover on the effects experienced by Samuel Witte (1) after a few inspirations of this gas, M. Devergie does not hesitate to place carbonic oxide among the deleterious gases (2)." * * *

So far we have given quotations expressing the general literature of this subject; now we will turn to the special departments which concern themselves with such substances as we consider carbonic oxide to be—namely, toxicology, the science of the detection and counteraction of poisons; hygiene, the science of preserving life and health from destructive agencies.

In Werker's Lehrbuch der praktischen Toxicologie, Erlangen, 1869, p. 81, we find as follows:

"Marsh gas, like hydrogen, is only irrespirable, but not poisonous. In the case of olefiant gas this is not absolutely established, for, according to some observers, it is said to produce a slight giddiness. Its effect is certainly a very slight one, and on account of the small quantity found in the gas it has probably no influence. We must then consider carbonic oxide as the poisonous principle."

Numerous other statements similar in effect, are found in the same work, but to quote them all would occupy too much space, and would not add to the force of what we have already transcribed.

Turning next to Eulenberg's Handbuch der Gewerbe-Hygiene, Berlin, 1876, p. 344, we find as follows:

"The effects of carbonic oxide agree with those of carbonic acid only in so far that with small quantities there may also be decided symptoms of irritation, which however, far more rapidly than in the case of carbonic acid, pass into general prostration." Then after enumerating at length the preliminary symptoms, he continues:

"If help is not rapidly rendered there follows prostration, with somnolency, enlargement of the pupils, cold perspiration, coldness, loss of feeling in the skin, relaxation of the muscles, difficult breathing, slow pulse, and then death rapidly follows."

On page 347 the author gives a series of experiments on doves and rabbits, with mixtures containing carbonic oxide and carbonic acid mingled with air, in various proportions from $\frac{1}{4}$ per cent. to $3\frac{1}{2}$ per cent., and then says in conclusion :

"We see, from these experiments, that a slight increase of the amount of carbonic oxide produces, altogether independently of the larger or smaller amount of carbonic acid, the characteristic symptoms of charcoal fume poisoning. Might not the prolonged action of small quantities of this gaseous mixture be of importance in the production of pulmonary affections ?"

On page 52 the same author says :

"For sanitary reasons, on account of the very poisonous properties of carbonic oxide, all processes in which this gas is produced should be very strictly watched."

M. G. Tourdes, whom we shall have occasion to quote presently in another connection, has published a pamphlet entitled "Rélation Médicale des Asphyxies occasionées à Strasburg par le Gaz de l'éclairage."

The incident here related and discussed was the poisoning (resulting fatally in several cases) of an entire family, caused by a leak from a pipe conveying water gas.

Devergie, in his Médecine Légale, Paris, 1852, vol. iii, p. 82, after quoting the experiments of Nysten on men and animals, says :

"These experiments plainly show the deleterious action of carbonic oxide, and the following, which was made and reported by Samuel Witte (Bibl. Brit. Sc. et Arts, lxi), leaves no doubt in this regard." He then describes the experiment, at the end of which he says : "The usual methods resorted to in cases of asphyxia remained without avail. He was then treated to oxygen gas, which brought him back to life."

On turning next to the immense work which bears the modest title "A handy book of Forensic Medicine and Toxicology," by Woodman and Tiely, London, 1857, we find on page 557, as follows :

"Carbonic oxide, when respired passes freely into the lungs, as much as four per cent. being found in the blood of animals exposed for from ten to twenty-five seconds to an atmosphere containing ten per cent. of this gas. When absorbed by the blood, it combines with the hæmoglobin." * * *

The poisonous action of carbonic oxide was noticed by Guyton Morveau in 1802 and by Sir H. Davy in 1810. * * *

Mr. Higgins, of Dublin, Tourdes, Leblanc, and Letheby, have also experimented with it. Tourdes proved that one part of gas in seven of air killed rabbits in seven minutes—one in fifteen, in twenty-three minutes — and one in thirty, in thirty-seven minutes.

Leblanc and Dumas' experiments show that air containing one per cent of the gas will kill a dog in one and a half minutes, and that birds die instantly in an atmosphere containing five per cent. Dr. Letheby found in his experiments that air containing one half per cent of the gas kills small birds in about three minutes; whilst if it contains one per cent it proves fatal in half the time.

An atmosphere containing two per cent rendered a guinea pig insensible in two minutes. There were no signs of pain—but the animals fell down insensible, and died at once, either with a slight flutter hardly amounting to convulsion, or gradually slept to death as if infected with a profound coma. Carbonic oxide is, in short, a pure narcotic poison. * * *

The large quantity of carbonic oxide in water gas (often 34 per cent) would render its employment dangerous as an agent of illumination.

REFERRING TO THE PRINCIPAL CONSTITUENTS OF ILLUMINATING GAS MADE FROM BITUMINOUS COAL, PROF. MORTON SAYS:

Marsh Gas.—Miller, in his Chemistry, vol. ii., p. 236, says that it is not injurious to life if diluted with air.

Leblanc, in the Ann. de Chém. et de Phys., 3d Series, vol. v., p. 239, says that marsh gas and olefiant gas are not injurious.

Eulenburg (Handbuch der Gewerbe Hygiene, already mentioned), at p. 368, says: "The action of marsh gas on the animal organism is in no way injurious to health; if headache, dizziness, fainting and similar effects are produced, it is certainly mixed with carbonic oxide. In coal mines such mixtures not unfrequently occur. According to the amount of carbonic oxide present, the workmen will be more or less affected with symptoms which never occur with pure marsh gas.

"Rabbits can remain in an atmosphere containing five per cent. of marsh gas for twenty minutes without showing anything abnormal.

"According to Richardson, seventy to eighty per cent of the gas is necessary to produce an anæsthetic sleep. In experimenting with animals this effect was not observed."

Fowne's Chemistry, Philadelphia, 1869, p. 169, under Marsh Gas: "It is not poisonous, and may be respired to a great extent without apparent injury,"

Hermann, Berlin, p 275: "Marsh gas has been proved to be indifferent."

Leblanc, Comptes Rendus, 1842, t. xiv, p. 868: "But some experiments made on animals demonstrated to me that even a very feeble dose of carbonic oxide may occasion very serious and even fatal accidents.

"Thus a dose of five per cent. in air will instantly kill a sparrow; a dose of one per cent. causes death in two minutes or more. Marsh gas, on the contrary, in a dose of one per cent., does not produce any serious effect even in a much greater length of time.

"Olefiant gas diffused in air to the extent of some hundredths does not produce any ill effects."

Hermann, p. 276: "Ethelyne gas (C^2H^4) I have proved on myself to be mildly intoxicating, almost like laughing gas."

In an article on "Gas and Gas making," L. P. Gratacap, Ph. B., says:

"Carbonic oxide concludes the list of heating gases. Its gravity is 0·967, its caloric power 2,400 units, and its calorific intensity 1,975°C. Carbonic oxide may be considered an adventitious member of coal gas constituents, and essentially is of no service. It is rather a necessary accident of gas making than a desideratum.

"In water gas it actually plays the same role as marsh gas in coal gas, and in the former marsh gas may be regarded as an accidental and undesirable event, just as the presence of carbonic oxide in coal gas is considered detrimental. Its poisonous properties are well understood, and on sanitary grounds its presence is obnoxious. In reality it is the only organic poison in coal gas, the other gases permitting inhalation, though of course devitalizing and injurious.

"In experiments made by the writer upon a gas containing small quantities of carbonic oxide, and upon a gas heavily charged with that body, the rapidity with which death ensued, upon the introduction of a rat into the latter, over that in the former was nearly proportional to the respective percentages of carbonic oxide in both."—American Gaslight Journal, August 16, 1880, page 78.

Extract from report of Gas Commissioners of city of Boston, 1876, page 30:

The second objection has much greater weight, and is, in our opinion, sufficient to entirely prevent the use of the mixed hydrogen and carbonic oxide alone for heating purposes, for the reason that, since it is devoid of odor, its escape from pipes and diffusion through the air of an inhabited room in dangerous amount could not be detected.

"In reference to the poisonous nature of this gas, the constituent carbonic oxide is one of the most active poisons, producing when inhaled speedy death. It does not act like carbonic anhydride, which, when it poisons, does so by merely preventing the entrance of air or oxygen into the lungs, as is the action of water in drowning, and persons can be as readily resuscitated after confinement in an atmosphere of pure carbonic anhydride as after confinement under water. Moreover, accidents from this gas can readily be prevented by a moderate dilution with atmospheric air. Carbonic oxide, on the other hand, is a true physiological poison, producing death almost as readily when diluted as when pure. It forms a compound with the red coloring matter of the blood, which is much more stable than that formed by carbonic anhydride, and cannot be readily decomposed by oxygen. 'Carbonic oxide is a gas of so poisonous a character that, according to Leblanc, one volume of it diffused through one hundred volumes of air totally unfits it to sustain life; and it appears that the lamentable accidents which too frequently occur from burning charcoal or coke in braziers and chafing dishes in close rooms, result from the poisonous effects of the small quantity of carbonic oxide which is produced and escapes combustion; since the amount of carbonic anhydride thus diffused through the air is not sufficient in many cases to account for the fatal result.'*

"When it was proposed to supply the Hôpital des Invalides in Paris with water gas, a commission was appointed, consisting of Messrs. Dumas, Chevreul and Regnault, eminent chemists, to investigate it. They found that it contained from thirty-four to forty per cent. of carbonic oxide, and reported that 'it would be dangerous to the occupants of the institution to introduce, even by way of experiment, gas obtained from the decomposition of water according to the Kirkham process.'†

"In the report of M. Pelonze‡ to the Municipal Council in June, 1854, there occurred the following passages in relation to

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*Bloxam's Chemistry, page 118.

†Report of the Committee on Public Buildings and Grounds, U. S. Senate, from London Journal of Gaslighting, June 10, 1856.

‡Ibid.

the gas of the Cromier Company: 'By this mode of manufacture we still obtain hydrogen mixed with carbonic oxide. Consequently all that has been said respecting carbonic oxide applies to the process of M. Cromier; and that being so, the use of this gas should be forbidden. As this gas is not mixed with any volatile oil, and is delivered for consumption without being carburized, it has no smell.' * * * * *

"In view of these facts we cannot consider the use of water gas as safe as that of coal or naphtha gas."

*OPINION OF CHAS. U. SHEPHARD, Jr.

Laboratory for Analytical Chemistry,
20 Broad Street, (up stairs),
Charleston, S. C., July 24, 1880.

Major Henry E. Young, *Charleston, S. C.*

In compliance with your request, I beg leave to submit herewith my objections to water gas.

It is dangerous.

According to the analysis, by their own chemist, of the commercial water gas manufactured according to the "Tessie du Motay" process, by the Municipal Gaslight Company of New York city, it contains about twenty-eight per cent. of carbonic oxide gas[1]

The amount of carbonic oxide in the ordinary coal gas may be stated as about six per cent.[2]

In fact the principal difference—from a hygienic standpoint—between the two gases lies in the larger content of carbonic oxide in water gas and of marsh gas (or light carburetted hydrogen) in coal gas. In the treatment of the intensely heated carbonaceous matter with steam, it is the object of the manufacturer of water gas to produce as much as possible of carbonic oxide—a combustible gas—to the end of diminishing the quantity of carbonic acid gas, which is incombustible. There is no feasible method of subsequently removing the carbonic oxide from the gaseous product, desirable as this step is regarded by all.

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*Note.—In order to ascertain whether this opinion was published as given by its author, and if he still held the same views, I wrote to him and received a response which will be found in connection with pamphlet entitled "Water Gas is Poisonous, authorities collated by H. E. Young, &c."

1 Report of Prof. Henry Wurtz to Charles D. Francklyn, President of the Municipal Gaslight Company of New York, March 4, 1878, Journal of Gaslighting, Water Supply. &c., May 7th, 1878.

2 Chemistry, hiorganic and organic, Bloxam, p. 141. Encyclopedia of Chemistry, vol. i., p. 994. American Gaslight Journal, March 2 and 16, 1878.

"Carbonic oxide gas is not only unfit for respiration, but it is deleterious. Not only can it suffocate, it poisons."[3]

"One hundredth part of this gas (carbonic oxide) mixed with pure air, renders it almost paralyzing for warm-blooded animals."[4]

"Carbonic oxide is a gas of so poisonous a character that, according to Leblanc, one volume of it diffused through one hundred volumes of air totally unfits it to sustain life."[5]

"Warm-blooded animals soon die in an atmosphere containing carbonic oxide, even a slight admixture, as low as one per centum, being sufficient" (to produce that effect).[6]

The small content of carbonic oxide in coal gas imparts to it its poisonous properties, since the more abundant constituents (hydrogen and marsh gases) are simply irrespirable, *i. e.*, non-life-sustaining, but are not poisonous, and the authorities seem agreed in estimating the deleterious effects of coal gas by its percentage of carbonic oxide.[7] But as water gas contains four to five times as much carbonic oxide as coal gas, it is not strange that numerous deaths have resulted from the substitution of the former for the latter, or that the use of an illuminating gas possessed of such deadly properties has been expressly forbidden in countries where the preservation of the citizen's life is a matter of serious governmental concern.[8]

The unignited escape of water gas for a few hours from an open burner of the ordinary size, into a close sleeping apartment of common dimensions, would introduce sufficient carbonic oxide to jeopard, if not destroy, human life, since (as before quoted) the contents of this poisonous gas has only to reach one per cent. to prove deadly to an unconscious sleeper.

Again, the products of the combustion of water gas are more deleterious than those of coal gas. When equal volumes of both are burnt, water gas produces about fifty per centum more

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[3] Traité Elementaire Chemie Medicale, Ad. Wurtz, vol. i., p. 239.

[4] Chemie appliquée a la Phyziologie, a la Pythologie, et a l'Hygiene. Gautier, vol. i., p. 14.

[5] Chemistry hiorganic and organic, Bloxam, p. 118.

[6] Lehrbuch der Experimentellen Toxicologie, Herman, p. 102.

[7] Handbuch der gurichtlichen Chemie, Sonnenschein p. 299. Handbuch der Toxikologie, Huseman, p. 657. Lehrbuch der praktischen Toxicologie, Werber, p. 82.

[8] Rep·rt of M. Pelouze to Municipal Council of Paris, June 24 and 28, 1854. Journal of Gaslighting, &c., May 28, 1878. American Gaslight Journal, June 16, 1880.

carbonic acid gas.[9] Consequently with the same consumption of water gas and coal gas, the atmosphere of an apartment would be much sooner vitiated by the use of water gas.

Perhaps the most terrible calamities arising from the inhalation of illuminating gas occur in houses into which the service pipes have not been introduced, but into which the gas finds its way through drains or other openings from a defective main, and where the true cause of the trouble is at first passed over owing to the non consumption of gas on the premises.[10] That under such circumstances the consequences would be much more serious with water gas than with coal gas, follows very naturally from my previous remarks on carbonic oxide. In fact widespread disorders which were at first regarded as epidemics of cerebro-spinal meningitis and typhoid fever have been traced to the presence of carbonic oxide in the atmosphere.[11]

(Signed) CHAS. U. SHEPHARD, Jr.

OPINION OF E. S. WAYNE, M. D.

Chemical Laboratory, 67 E. Fifth Street,
Cincinnati, Ohio, Nov. 29, 1871.

Dear Sir: The production of illuminating gas by the vapor of water passed through coal, coke or other forms of carbon, heated to a red heat, or beyond, is by no means a novelty. It was originally discovered by Selligue, of Paris, between thirty and forty years ago; at the time of its discovery it was thought to be an advance in the economical production of illuminating gas, as it produced from a given weight of coal or coke an increased volume, and also one of higher illuminating value than gas made from coal in the usual way.

Chemical examination of the gas proved that it contained a very large amount of carbonic oxide, a highly deleterious gas, but its use was attended with so much risk of life that it was never extended, and I believe was positively forbidden by the authorities at Paris.

Gas made by the water process, no matter what form of carbon may be used, whether anthracite, coke, &c., according to the analysis of it, made by M. Langiots, Paris, always contains a

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9 "Carbonic Oxide," Prof. Henry Morton, American Gaslight Journal, March 2 and 16, 1878.

10 Gewerbe Hygiene, Eulenberg, p. 352; Beziehungen der Luft zu Kleidung, Wohnung und Boden von Pettenkoffer, p. 87.

11 Gewerbe Hygiene, Eulenberg, p. 602.

nearly constant quantity of carbonic oxide; the volume of this dangerous substance he found to be from twenty to twenty-six per cent.

To show the deleterious character of this carbonic oxide, and how small a quantity of it it takes to make a mixture with atmospheric air fatal to animal life, I will transfer and quote from Traite de Chemics, by Pelouze & Fremy, Paris, page 913:

"If a bird were placed under a glass and 0.025 of it introduced and free from carbonic acid, the bird becomes uneasy, spreads its wings and falls dead in less time than a minute." In summing up, he says the gas extracted by water can be employed only in very limited cases, and it will always present the grave inconvenience we have just indicated.

In comparison with coal gas, that made by so-called water process contains five or six times the quantity of carbonic oxide; consequently its use, as mentioned by the celebrated French chemists in quotation above, must be attended with serious danger. An atmosphere containing only 0.01 per cent of it is more dangerous than one containing 0.25 per cent of carbonic acid; from this may be understood the dangerous consequence to life by the accidental escape of gas containing so large a proportion of carbonic oxide—20 to 26 per cent—into a close room at night, from leak in the gas fixtures, or a light accidentally put out, or a tap not completely shut off; such accidents do occur with the use of coal gas, and will also with the use of water gas. We often read and hear of such accidents with gas, but they are seldom fatal, and the victims of such accidents, by removal to pure atmosphere, soon recover. But I am very much of the opinion, should the leak occur with water gas, that the victim when found would be past human aid; instead of the physician, there would be a call for the coroner. Another fact which makes water gas more dangerous than coal gas is that it is about double the specific gravity of coal gas, also heavier than the air, and consequently will not diffuse itself rapidly, but settle to the lower portions of the room and render the atmosphere there quickly dangerous to the occupants. Coal gas, on the other hand, is lighter than atmospheric air; it ascends and only slowly diffuses itself down towards the lower parts of the room, where its more intense and easily recognized odor will soon give notice to the occupants that something is wrong, and insure an investigation to find out and remedy the defect.

The toxic effect of carbonic oxide, a blood poison, is very different from that of carbonic acid; it is frequently used as a means of suicide and seldom fails in carrying out its intent.

The combustion of coal and water gases yields carbonic acid, as well as containing more or less of it in the gas. It is a gas that is exceedingly objectionable, and without having the toxic property of carbonic oxide is the cause of much discomfort when escaping into the atmosphere of a room, causing headache, vertigo, &c.; consequently it is desirable that in the use of illuminants we select that which yields during its combustion the smallest amount of carbonic acid. Coal gas yields fifty per cent less of it than water gas.

To sum up the objections to the use of water gas, they are as follows:

First—Its great specific gravity prevents its diffusion in case of a leak.

Second—The large per cent. of carbonic oxide in it, and its toxic character.

Third—That its combustion yields double the amount of carbonic acid that coal gas does.

For the above reasons the introduction of water gas for general use is a matter that should be thoroughly weighed, and not hastily decided upon by the authorities: and it is also of enough importance to warrant a full investigation by the Board of Health.

E. S. WAYNE, M. D.,

Chemist.

N. T. LUPTON, PROFESSOR OF VANDERBILT UNIVERSITY, Says:

"The deleterious effects of coal gas, after the removal of gases containing sulphur, are generally estimated from its percentage of carbonic oxide, and as water gas contains from four to five times as much of this poisonous constituent as coal gas, its use has been condemned as dangerous to health.

"The products of the combustion of water gas are also more deleterious than those of coal gas, since a much larger quantity of carbonic acid gas is produced. A given volume of water gas produces, when burned, about fifty per cent. more of carbonic acid gas than is produced by the combustion of an equal volume of coal gas."

CHAS. M. CRESSON, M. D., THE EMINENT CHEMIST OF PHILADELPHIA, PA., Says :

"Asphyxia by carbonic acid, hydrogen or olefiant gas, is not poisonous, The action of carbonic oxide upon the human system is of a different nature from that produced by any of the gases enumerated. In addition to asphyxia, carbonic oxide produces an organic change in the blood, a poisonous change, which, when once established, places the patient beyond the reach of antidotes."

THE EMINENT AND UNQUESTIONED AUTHORITY, DR. N. U. SCHILLING, IN HIS TRAITÉ D'ECLAIRAGE PAR LE GAZ. DE HOUILLE, EDITION, 1879, Page 174, Says :

"It is certain that carbonic oxide is the only constituent of illuminating gas that is fatal in its effects. This gas, carbonic oxide, it is believed, possesses such an irresistible chemical attraction for the blood that it drives out the atmospheric oxygen and substitutes itself for it. The blood then becomes unfit for carrying on the vital functions, death occurs, not by asphyxia, but by poisoning."

THE ACTIONS AND OPINIONS OF THOSE INSTRUMENTAL IN INTRODUCING WATER GAS INTO THE CITY OF NEW YORK, REGARDING ITS DANGER.

The manufacturers of water gas, seeing the fatal results from its use, began in 1881 to attempt the removal of the poisonous carbonic oxide, as evinced by the extracts from the following letter of civil engineer John F. Harrison, to E. Stern, Esq., original promoter of water gas in New York city.

New York, September 8, 1882.

E. Stern, Esq. :

According to an arrangement made with you in January last, that in conjunction with M. Jerzmanowski I should conduct an experiment at the works of the Municipal Gas Company on Forty-first street near Eleventh avenue, for the purpose of determining the practicability of manufacturing gas for illuminating and other uses by the decomposition of steam in the presence of quick lime and thereby getting rid of the noxious element of carbonic oxide so abundant in the ordinary process of water gas manufacture, by transferring it into carbonic acid while in the nascent state, to be subsequently removed by proper appliances,

I will state that from May 10 to June 5, both inclusive, we made fifty-seven experiments and thereby ascertained all the essential features of the problem could be attained. * * *

Respectfully submitted,

JOHN F. HARRISON.

We now come to the verification of Prof. Henry Morton's predictions, at which some of his wise or interested professional brethren cavilled when made, although it is with regret that such a record should go forth, proving either the culpable ignorance of our boards of health or their scientific advisers, or else a scandalous disregard for the human lives committed to their care.

[For list of fatal and serious accidents resulting from the inhalation of illuminating water gas in New York city and the city of Brooklyn, from 1878 to 1882, see page 93.]

As a complimental proof of the correctness of the opinions before stated, it may be noted that the same fatal effects, but in a still greater degree, comparatively, have followed the introduction of water gas into the following cities, viz.: Indianapolis, Ind., Toronto, Can., Newburg, N. Y., Middletown, Conn., Rondout, N. Y., Dover, N. H., Paterson, N. J., Scranton, Pa., Baltimore, Md., Pullman, Ill.

CONCLUSION—THE REMEDY SUGGESTED.

The public has bestowed a most valuable franchise on the distributors of illuminating gas. These privileges, from the special character of the business, are more valuable and exclusive than those given to any other corporations.

In return for these grants the public has the right to demand that its interests be subserved, certainly to the extent that the lives of its urban populations be protected, and not jeopardized simply for the lucre of those exercising chartered privileges.

It is true the developments of our civilization demand that certain risks be taken, so that the enjoyment of our comforts or luxuries may be more complete, but where life is perilled in the remotest degree, the highest civilization, morality and intelligence demand that the greatest care be taken, and this regardless of the expense attending such precautions, and that no risk be run unless it be absolutely necessary, and that the public receive benefits much greater than are equivalent for the hazards to which it is subjected.

Has the public reseived any compensation for the distribution of water gas? None whatever. If there is any benefit the manufacturer has alone profited by it.

Then why should the distribution of water gas be allowed here? Are lives less valuable than where it has been interdicted in Europe, as shown above, or in the State of Massachusetts, and in several other States and cities where, after careful examination, we understand its manufacture is not allowed?

There is no reason why the carbonic oxide in water gas is not kept down to five per cent. instead of thirty, except the greed of the manufacturer.

Water gas containing but five per cent. of carbonic oxide would be comparatively harmless, and such a gas was made and distributed for several years in Narbonne, France; it contained less than four per cent. of carbonic oxide.

The description of mode of manufacture, plans of the plant, and analyses of the gas may be found in the Journal fur Gasbeleuchtung und Wasserversorgung, year 1859, page 374; year 1861, page 90; also in the Journal de l'eclairage au gas, year 1859.

Extract from the American Gaslight Journal, year 1860, page 121: The gas which is used for lighting the city (Narbonne), is almost pure hydrogen.

Carbonic oxide can also be removed by the Spencer process; see London Journal of Gaslighting, July 29, 1873, page 686. It is stated in report of civil engineer John F. Harrison, quoted above, that it can readily be removed.

This being so, why is it not removed?

Because the public is careless of its rights.

The remedy is in its hands; do not permit the distribution of any gas containing more than ten per cent. of carbonic oxide under severe penalties.

Deaths by the inhalation of illuminating gas will then be events almost unheard of.

APPENDIX E. PAPER 20.

WATER GAS.—IS IT A DANGEROUS POISON?

They had a Scare Crow once in New York.
Result: More Water Gas used than Coal Gas.
It did not scare worth a cent.
The Scare Crow has been brought to Brooklyn.

"The recent attempts to introduce water gas, as an illuminating agent, renders the above question one of vital interest to every person using gas, either for lighting, heating or cooking.

"Water gas is obtained by passing steam over and through anthracite coal, and as the steam is decomposed by the ignited carbon the hydrogen is set free and carbonic oxide produced, and for illumination, enriched with crude oils, naphtha, &c.

"The only poisonous constituents of any illuminating gas is its carbonic oxide, as the following quotations from standard authorities abundantly prove.

"The gas containing, therefore, the larger percentage of this insidious poison is the more dangerous to use.

"From the best authorities the following is the analysis of water gas and ordinary coal gas, the latter safely and satisfactorily used in Brooklyn for upward of twenty-five years.

WATER GAS.		COAL GAS.	
Carbonic acid	.371	Carbonic acid	1.950
Oxygen	1.021	Oxygen	.139
Olefines	17.363	Olefines	5.504
Carbonic oxide	27.893	Carbonic oxide	4.167
Hydrogen	23.487	Hydrogen	45.857
Marsh gas	24.612	Marsh gas	40.948
Nitrogen	5.235	Nitrogen	1.445
	99.982		100.000

"It will be seen by the above that water gas contains nearly seven times as much carbonic oxide (a rank poison) as ordinary coal gas, and is seven times as dangerous to use.

"Quite recently strenuous efforts have been put forth to induce the use of naphtha water gas as an agent for illumination, but so great has been the popular dissatisfaction in this country and abroad, that laws have been passed prohibiting its manufacture and sale. Both the States of Massachusetts and New Jersey, after the most thorough and patient investigation, have recently enacted laws prohibiting the manufacture and sale of this character of gas."

To please coal gas companies.

"Selligue, in 1840, obtained permission to use the gas in the towns of Dijon, Strasburg, Antwerp and two of the faubourgs of Paris and Lyons."

"I am confirmed in my conclusions that whatever dangers to life and health, may or do arise from the use (or rather abuse) of illuminating gases, these will not be enhanced in any way by an increase in its proportion of carbonic oxide.

PROF. WURTZ."

"The allegation that this 'water gas' has been prohibited in Paris is directly denied by Prof. Adolph Wurtz of that city."

(See report of Board of Health to the Board of Aldermen, New York City, April 15, 1881.)

Report of Prof. Henry Morton, December 8, 1879:

"You will see that I not only agree with Prof. Wurtz in considering carbonic oxide as rendering all gases which contain it more or less dangerous, but also regarded the danger from any gas as so small, and modified by so many other conditions, that this question need not, and undoubtedly would not, influence the practical adoption of any gas for domestic uses, provided it were otherwise desirable."

"At Strasburg, an accident occurred which put a stop to its use.

"The gas escaped from the pipes into a baker's shop and was fatal to several persons, and not long after an aeronaut named Delcourt, incautiously used the gas for inflating his balloon, he was made insensible in the car, and those who approached the balloon to give him assistance fainted and fell likewise.

"The use of the gas has been interdicted on the continent of Europe.

"The cities of Boston, Mass., and Cincinnati, Ohio, after a most thorough and searching investigation refused by their municipal authorities to allow the sale of naphtha water gas.

"And the day is not far distant when our legislative authorities will pass laws preventing its manufacture and use."

If coal gas companies control them.

"We quote from eminent chemists whose opinions are known and respected:

"Prof. Henry Morton, President of Stevens' Institute of Technology, says: 'Carbonic oxide stands condemned as a rank poison, very exceptionally dangerous as compared with other constituents of illuminating gas.'

"Thenard's Chemistry, Paris, 1834, t. i., p. 274: 'carbonic oxide, it kills immediately, the animals who breathe it.'

"Reisig Munich's Handbook on Coal and Water Gas (page 59) says: 'This latter gas in particular is dangerous on account of its large contents of carbonic oxide.'

"Hydrogen and light carburetted hydrogen can be much more readily respired without injurious consequences.

"But not so carbonic oxide; the poisonous effects of this gas are known.

"Bernard Lecons, sur les effet des substances toxiques, Paris, 1856. This author says:

"Carbonic oxide is one of the most poisonous gases known."

"Schorlmmer Chemistry of Carbon Compounds, London, 1874, p. 63, under carbonic oxide. 'It is but sparingly soluble in water and acts as a strong poison, producing death when inhaled even in small quantities.'

"Stockhardt's Chemistry, p. 100: 'Carbonic oxide is extremely poisonous.'

"Hassett, the distinguished German chemist, says: 'Carbonic oxide has been found to be a most active narcotic poison for man.'

"Charles M. Cresson, M.D., the eminent chemist of Philadelphia, Pa. 'In addition to asphyxia, carbonic oxide produces an organic change in the blood, a poisonous change, which places the patient beyond the reach of antidotes.'

"E. S. Wayne, M. D., of Cincinnati, who is probably the most eminent chemist in the United States, says: 'The so-called water gas contains five or six times the quantity of carbonic oxide, consequently its use must be attended with serious danger. I am very much of the opinion should a leak occur (which is of frequent occurrence) the victims of such accident, when found, would be past human aid, instead of a physician a coroner would be required.'"

Only opinion, he had no facts.

R. Ogden Doremus, Professor of Chemistry and Toxicology, Bellevue Hospital Medical College, New York:

"Having been informed that parties are circulating reports that the gas furnished by your company is particularly poisonous, and having been requested to express an opinion on this subject, I beg leave to state that the trivial variations in the gases made by different processes is of no importance in regard to health, excepting as to the products of their combustion. In this respect your gas is superior to all others, as it does not contain impurities existing in gas manufactured from bituminous coal."

E. Frankland, Professor of Chemistry, Royal College of Chemistry, South Kensington Museum, London, England:

"I have no hesitation in saying that it may be used with safety both in public and private houses. I should be delighted to substitute this pure and powerful agent for the gas with which my house in London is at present supplied."

We have also reports from Henry Wurtz, Ph.D., of Hoboken, N. J, and Ad. Wurtz, Membre de l'Institut, Professeur a la Faculté de Medicine et a la Faculté des Sciences, Paris, France, confirming the statement that the products or effects of burning this gas are less objectionable, to a marked extent, than with gas from gas coal.

"No accumulation of citations of vague and crude opinions, stereotyped through generations of school books as to the danger of small percentages of carbonic oxide in air, should have any influence on reasonable minds, when it is only by rare accident or stupidity that even these small percentages can be communicated to the air of a close room.

PROF. WURTZ."

"Webster defines carbonic oxide a compound of carbon and oxygen. 'It is fatal to human life.'

"Appleton's Encyclopedia says: 'Carbonic oxide, or oxide of carbon, is a colorless gas without smell or taste, but more irrespirable and poisonous than carbonic acid, its inhalation causes immediate asphyxia.'

"Booth's and Tabor's Chemistry, page 321, a text book in most of our schools, public and private, teaches the pupils that carbonic oxide is a powerful narcotic poison. When breathed it is fatal. It produces before death giddiness and insensibility, followed by profound coma.

"Townes Chemistry, page 168, another acknowledged standard text-book: 'Carbonic oxide is colorless, has very little odor and extremely poisonous.'

"N. T. Lupton, Professor of Vanderbilt University, Tennessee, says: 'The products of the combustion of water gas are more deleterious than those of coal gas, since a much larger quantity of carbonic acid gas is produced. A given volume of water gas produces, when burned, about fifty per cent. more carbonic acid gas than is produced by the combustion of an equal volume of coal gas.'

"But why go on and multiply authorities acknowledged and respected, all of which lead to same conclusions?"

Oh do! Scare some more!

"We would call your attention to these facts as stated above, and beg you to notice that these are the published statements of disinterested authors and teachers, and not the opinions of paid experts."

And circulated by disinterested companies!

"It is the daily experience of gas companies that complaints reach them of leaks occurring in cellar parlors, or sleeping apartments.

"During the past quarter of a century in very few instances deaths have occurred from inhaling inordinate quantities of coal gas, while since the introduction of water gas (less than four years, in the cities of New York and Brooklyn) we have on

record a long list of persons killed by its deadly effects, with many more who have been overcome by inhaling it and have probably died."

When facts are wanting, draw on your imagination.

"Should any persist in its use notwithstanding the extreme danger attending it, great caution should be exercised and care taken to turn off the flow every evening by some entirely reliable person, so that not even a small quantity could by any possibility escape."

Take the same care with any gas.

"The various quotations from eminent chemists and others given thus far, make it abundantly manifest that, in the opinion of the standard writers on chemistry as expressed in their publications, carbonic oxide is one of the most virulent and dangerous gas poisons, the presence of which, even to the extent of a few per cent. in the air of a room, renders it utterly unfit for breathing, producing headaches, &c., and often fatal to human life."

And yet they continue to sell coal gas, which they admit contains a few per cent. of carbonic oxide!

How consistent!

Carbonic oxide, like alcohol, has its uses and abuses.

Pure carbonic oxide has been used safely as an anæsthetic agent, upon man as well as upon lower animals, by Ozanam and Tourdes, both these famous authorities comparing the symptoms to those of chloroform.

Hot steam is often fatal to life, but tea kettles are still used.

Persons may drown in bath tubs, but water will continue to be introduced.

"Stoves and furnaces through accident or defect often emit carbonic oxide into our dwellings to a far greater extent than could proceed from any leak in gas pipes. Yet stoves and furnaces are not practically condemned for this.

PROF. WURTZ."

State of New York, County of Kings, *ss.*

Robert W. Lindsly, being duly sworn, deposes and states as follows: I reside at number 485 State street, in the city of Brooklyn, and am over the age of twenty-one years. During the past three days, at the request of the Fulton Municipal Gas Company, of the City of Brooklyn, I have examined a pamphlet which has been circulated in this city, entitled "Water Gas, a Dangerous Poison," and have carefully examined all the newspapers mentioned on pages 7, 8, 9, 10 and 11 of said pamphlet, except the newspapers called the "Yonkers Gazette," the "New York Star," and the "New York Mercury," and none of the statements appearing on such pages, so examined by me are correct copies from the respective papers from which they purport to be extracts. None of the newspapers so examined contain the words "Water Gas" in connection with accident or danger, or in any other form, but in several of the said newspapers at the times referred to as having been caused by gas. In none of such papers so examined did the words or term "Water Gas" appear, and the items or alleged quotations on said pages of said pamphlet are wholly incorrect to that extent.

Many of the said alleged quotations are wholly incorrect, and different in purport and effect from the newspapers from which they purport to be taken, and all of them are to some extent garbled and misleading.

ROBERT W. LINDSLY.

Sworn to before me this 28th day of July, 1882.

A. R. JOHNSON,

Notary Public, Kings Co.

ACTION OF CARBONIC OXIDE WHEN INHALED.

"The phenomena produced by the inhalation of carbonic oxide naturally divide themselves into five periods:

1. Premonitory stage.
2. Period of excitement. ?
3. Period of anæsthesia.
4. Death.
5. Coroner.

"Can any one afford to take the chance of injuring the health and lives of himself and loved ones by patronizing any company or corporation that offers for sale this poisonous gas.

"As a practical illustration of the foregoing, we quote from among the many instances where serious and fatal results have followed the use of this pernicious and deadly agent, all of which have occurred within the last four years, and hardly an instance from coal gas during the same period.

"Nicholas Le Roy, St. Cloud Hotel, New York city, died April 25, 1878, from inhaling water gas, the cock having been left turned on by mistake in his room.—N. Y. World.

"John Brown, No. 31 Bowery, New York, met his death on November 8, 1878, by inhaling water gas.—N. Y. World.

"Susan Cochrane, No. 53 East Twelfth street, New York city, died on January 23, 1880, from inhaling water gas.—N. Y. Tribune.

"John Donovan was killed by inhaling water gas, at 115 West Twenty-first street, New York city, on May 3, 1880.—N. Y. Herald.

"Lewis Baker died at French's Hotel, New York city, by inhaling water gas, May 19th, 1880.—N. Y. Herald.

"Fifteen young ladies, employees of Messrs. Copcutt & Co., were nearly suffocated, and were with great difficulty brought back to consciousness.—Yonkers Gazette, October 16th, 1880.

"Sofio Ingenito, 79 Spring street, New York, killed October 30th. 1880.—N. Y. Tribune.

"William Drummond was suffocated at 311 East 11th street, New York.—N. Y. Times, October, 1880.

"Bertha Wiesse was killed at 233 Henry street New York.—N. Y. Times, November 5th, 1880.

"J. Eloshy was killed at Crook's Hotel.—N. Y. Times, November, 1880.

"F. Broge was suffocated in the Summit Hotel, corner Bowery and Canal street.—N. Y. Papers, November 19th, 1880.

"Thomas Colman was killed at the Putnam House, Fourth avenue, New York, on December 3d, 1880.—N. Y. Papers, December 4th, 1880.

"J. Forester and wife died at the Pyle House, Indianopolis, Ind. On retiring they opened the top of one of the windows of their room, also the transom over the door, but the gas being heavier than air, killed both parties."

REPORT OF PROF. C. F. CHANDLER,

President of the Board of Health,

TO THE BOARD OF ALDERMEN, CITY OF NEW YORK.

The President laid before the Board the following communication from the Board of Health:

HEALTH DEPARTMENT, NEW YORK, April 15, 1881.

To the Honorable the Board of Aldermen:

At a meeting of the Board of Health, held on the 13th inst., the following report of the President was unanimously adopted, and a copy was ordered to be forwarded to your Honorable body:

REPORT.

I have the honor to report that the petition of citizens referred to the Board of Health by the Honorable the Board of Aldermen, with regard to the illuminating gas which is manufactured from steam, anthracite coal and naphtha, the so-called water gas, has been duly considered.

This gas has been extensively used in the city of New York for some years in public and private buildings. While it differs somewhat in composition from the gas manufactured from bituminous coal, it involves in its careless use the same sources of danger; if allowed to escape into the air without being burned it produces an explosive mixture with the air, and it is also liable to suffocate persons who may remain for any length of time in the atmosphere thus contaminated. There are no facts which give any substantial foundation for the apprehensions of the petitioners that this gas is in any way more dangerous than the gas previously in use. I would further state that the allegation that this water gas has been prohibited in Paris is directly denied by Professor Adolph Wurtz, of that city, in a letter which I have before me; that the greater density of the gas causes it to escape more slowly from leaks than does ordinary coal gas, and that its odor is so decided that leaks are detected just as readily as in the case of other gas. In conclusion I would say I see no reason why any official action should be taken on this subject.

C. F. CHANDLER, *President*.

(A true copy.)

——— ———, *Secretary*.

Which was referred to the Committee on Police and Health Departments.

"Two men were suffocated at No. 80 Duane street, New York, by water gas.—N. Y. Papers, December 10th, 1880.

"S. Sherwood, of Westport, R. I., who was suffocated with gas in a room at Earle's Hotel, died yesterday in St. Vincent's Hospital.—N. Y. Times, December 17th, 1880.

"R. A. Stillwell was killed by water gas at North River Hotel, corner West and Barclay streets.—N. Y. Times, December 25th, 1880.

"Frederick Albers was rendered unconscious by inhaling water gas at Summit Hotel, Bowery, and was with great difficulty revived—N. Y. Tribune, December 27th, 1880.

"R. B. Reynolds was killed by water gas at Van Dyke House, Bowery.—N. Y. Times, January 3d, 1881.

"John Brennan was rendered unconscious by inhaling water gas at New England Hotel, Bowery.—N. Y. Papers, January 22d, 1881.

"Patrick Nolan, killed by water gas at No. 10 First street, New York city. A woman who was lying by his side was removed to Bellevue Hospital, where she died.—N. Y. Herald, January 1st, 1881.

"Michael Lynch, 27 East 27th street, rendered insensible by inhaling water gas.—N. Y. Sun, January 14th, 1881.

"John Braman, 30 Bowery, suffocated by water gas.—N. Y. Sun, January 22d, 1881.

"John Gallen and H. Knapp were nearly suffocated by water gas at the Central Hotel, corner Canal and Elm streets.—N. Y. Sun, January 24th, 1881.

"Henrietta Bravedoffer and Barbara Weis were killed at the house of F. Handrich, Third avenue, near 57th street, New York.—N. Y. Papers, February 12th, 1881.

"Gustav Bertlein was killed by water gas at 310 Broome street.—N. Y. Sun, April 4th, 1881.

"Andrew O'Donnell was killed by water gas at Summit Hotel, Bowery.—N. Y. Star, April 8th, 1881.

"Sophia Vensen was killed at 200 West 56th street, New York. —N. Y. Tribune, April 25th, 1881.

"Three men were nearly killed by water gas at the Putnam House, 26th street and Fourth avenue, New York.—N. Y. Mercury, November 13th, 1881.

"Thomas J. Durand was killed by water gas at the Occidental Hotel, Bowery.—N. Y. Tribune, February 17th, 1882.

"R. H. Stryker was killed by water gas at Bridge Hotel, Chatham street.—N. Y. Tribune, March 2d, 1882.

"Frederick Hoffman was killed by water gas at North River Hotel, Barclay street.—N. Y. Tribune, March 2d, 1882.

"Two women were nearly killed at 106 East 14th street, New York.—N. Y. Tribune, May 31st, 1882.

"Wm. Makin and wife were killed by water gas at Mortimer's Hotel, Morris street.—N. Y. Sun, June 2d, 1882.

"P. R. Covert was killed by water gas at French's Hotel.—N. Y. Tribune, June 2d, 1882."

BROOKLYN VICTIMS.

"Four men were seriously injured from escaping gas at the Fulton Municipal Gas Works, Brooklyn. Peter Quinn, one of the victims, although not killed, was in a precarious condition, removed in an ambulance to the Long Island College Hospital.—Brooklyn Eagle, April 17th, 1880."

"Two laborers were stupefied in open air while opening street mains of the Fulton Municipal Gas Company, of Brooklyn, corner of Fulton and Oxford streets, November 15th, 1880.

"A laborer employed in putting in service pipe for Fulton Municipal Company, at Singer's Sewing Machine Company, Fulton street, was overcome by gas.—April 1st, 1882.

"Matilda Hogfeldt was killed by water gas at 296 Sackett street.—Brooklyn Union-Argus, April 15th, 1881.

"Pat. Cook was killed by water gas at the works of the Fulton Municipal Gas Company, Brooklyn.—Union-Argus, July 11th, 1881.

"John Agins was suffocated by water gas at the Clinton House, Brooklyn, was removed to Long Island College Hospital, where he died.—Union-Argus, October 13th, 1881.

"Julia Neilson and Nina Lawson were rendered unconscious by inhaling water gas at 49 Tompkins place, Brooklyn.—Eagle, October 15th, 1881.

"Richard Smith was nearly suffocated by water gas at 17 Red Hook lane, Brooklyn.—Union-Argus, March 7th, 1882.

"W. King, of West Randolph, Vt., was suffocated by water gas at the Clinton House, May 13th, 1882, and was with great difficulty revived.

"A. H. Coldwin, of Boston, was nearly killed by water gas at the Pierrepont House. When discovered he was unconscious. Physicians were summoned, and after working over him for two hours, he was restored to his senses.—Brooklyn Daily Eagle, April 17th, 1882."

APPENDIX E. PAPER 21.

A Summary of Cases Reported

IN THE

ENGLISH AND AMERICAN LAW REPORTS,

Relating to the Injury of Person and Property from the Escape and Explosion of Illuminating Gas.

June, 1883. Prepared by Stephen C. Betts, Law Librarian.

Actions for injuries to person and death from inhaling illuminating gas.

Holly *vs.* Boston Gas Light Co. 1854. 8 Gray, 123.

Action of tort brought by an infant of nine years of age, for injury to the plaintiff in her father's house, South street, in the city of Boston, January, 1854, from inhaling gas which escaped from the street and next door and ascended into the house to plaintiff's room in the third story of the house. The smell of gas was discovered by the father at eleven o'clock in the morning; a strong smell at the time of the child's going to bed, between 8 and 9 o'clock in the evening, and later, at 11 o'clock P. M., when the window in the child's room was drawn down fully from the top. Early in the morning the plaintiff was found on the floor nearly insensible. She had been vomiting from the effects of the gas. Upon being brought into the air outdoors, together with medical treatment, the plaintiff recovered.

Hunt (Aaron) and others *vs.* Lowell Gaslight Co. 1861. 1 Allen, 343 (and 3 Allen, 418).

Action for injury to the health of the several plaintiffs, occasioned by the flow and escape of gas from a main pipe of

the defendants, laid down in Middlesex street, Lowell, through a sewer and drain into a tenement occupied by the plaintiffs. There was no gas pipe in the tenement. The smell of gas was first discovered in the kitchen, on January 27, 1857. Aaron Hunt was taken ill about one week after, and Edwin R, Hunt, his son, and Annis, a boarder, became ill. About the 13th of February a daughter of Aaron Hunt died.

See also two cases following.

Emerson (E. W.), *vs.* Lowell Gaslight Co.
Emerson (**H. A.**) *vs* same. 3 Allen, 410 (and 6 Allen, 146).

Two actions of tort tried together against a gaslight company, for an injury to the plaintiffs' health from the inhalation of gas which escaped from the defendants' pipes.

In January, 1857, the gas escaped from the defendants' main pipe in Middlesex street, in the city of Lowell, under the same circumstances stated in Hunt *vs.* Lowell Gaslight Co., 1 Allen, 343.

Hunt (Geo. L.) *vs.* Lowell Gaslight Co.
Same and wife, *vs.* same. 8 Allen, 169.

Two actions of tort tried together against a gaslight company for an injury to the plaintiffs' health from the inhalation of gas which escaped from the defendants' pipes.

The evidence tended to show that the plaintiffs lived in New Hampshire, and on the 4th of February, 1857, came to the house of Aaron Hunt, in Lowell, and remained there for nine days; that gas had escaped into the house under the circumstances in 1 Allen, 344, (through the sewer and a drain to the house,) and the plaintiffs became ill and returned home, where they were sick for several weeks. The plaintiffs were allowed to prove that up to that time the family of said Aaron had been in perfect health, and that immediately or soon after the escape of the gas into the house, every member of the family became seriously sick. Three physicians testified that the sickness of the plaintiffs was of a low typhoid type, and that the breathing of gas as stated by them at the house of Aaron Hunt was the cause of it.

Smith *vs.* Boston Gaslight Co. 1878-80, 129 Mass., 318.

Action of tort for personal injuries occasioned to the plaintiff, a minor, under five years of age, by the inhalation of gas, which

escaped from the defendants' pipe. The escape of gas which caused the injury to the child, at the same time caused the death of his mother. The two occupied the same room and bed. There were no gas fixtures in the room. The escape of gas came from a crack in the pipe laid by the defendant through the street, Thacher Court, on which plaintiff lived.

Actions for injuries to person from escape and explosion of illuminating gas.

Mose and wife *vs.* The Hastings and St. Leonard Gas Co., 1864, 4 Fost. & Fin., 324.

December 23, 1862, gas escaped from fractured main into plaintiffs' house in large quantities, then caught fire and exploded, causing injury to the plaintiff and his wife. The plaintiffs did not use gas.

Parry *vs.* Smith, 1879, L. R., 4 C. P. D., 325.

Gas escaped from a temporary connection made while defendant was repairing meter. The plaintiff having gone in the ordinary performance of his duty with a light into the cellar where the meter had been; gas, which had escaped by reason of the insufficiency of the connecting tube, exploded and injured him.

Brown *vs.* The N. Y. Gaslight Co., 1850, Anth. N. P., 351.

The case as stated, shows that the gas escaped from the main gaspipe, which seemed to have a recent fracture where the earth had sunk or caved away, opposite the vault, in front of No. 4 Courtlandt street, New York, June 15, 1849, during great alterations on both sides of the street. An examination showed that the gas insinuated itself through the loose sand into the vault.

The plaintiff was a house mover, and in the line of his calling was at work at No. 4 in that street on the 15th of June, and had occasion to go into the vault for his tools, and called to one of his men to bring him a light, the vault being a dark one. He was in the vault searching for what he required when the light was brought, and instantly the gas which had been accumulating there exploded, and so severely burnt the plaintiff that he was deprived of all power of attending to his business for a period of about six weeks, suffered great bodily pain, and his life was considered for a part of the time in much danger.

Lannen, an infant, *vs.* Albany Gaslight Co., 1865; 46 Barb., 264 (aff'd 44 N. Y., 459).

Damages for injury received by plaintiff (seven years of age), from an explosion of gas, December 6, 1861. The gas escaped through a leak in the service pipe introduced by defendant, and gas ignited by match lit by defendants' servant in looking for the leak. The effect was terrible and instantaneous. The interior of the house was blown to pieces. The plaintiff and her mother were blown up to the ceiling of the room they were in on the first floor, and then fell through the crushed and broken floor together with pieces of boards and timber into the cellar. The plaintiff's left thigh bone was broken. The leg bone was sticking through the flesh two or three inches; a flesh wound above the knee pan; thigh bone protruding through this flesh wound; the bone was completely peeled off; it was necessary to saw off three inches of the bone; there was a permanent shortened limb and stiff knee joint; the limb is two inches shorter; there was a great deal of suffering, and the plaintiff was confined to her bed three months.

Kimmel *vs.* Burfeind, 1866; 2 Daly, 155.

Action brought by plaintiff, who was a tenant of defendant, to recover damages for injuries sustained by her by reason of an explosion of gas in her apartments. The fixtures were removed from the gas pipes, leaving the latter open and uncovered. The apartments were afterwards occupied by plaintiff. The tenant on a lower floor introduced gas, July, 1865, and an explosion took place, causing injury to the plaintiff.

Flint *vs.* Gloucester Gas Co. 3 Allen, 343, and 9 Allen, 552, 1859.

Escape of gas from uncapped pipe in room; explosion; injury to plaintiff's wife.

Hutchinson *vs.* Boston Gaslight Co., 1876–77. 122 Mass., 219.

Action for injuries sustained by the plaintiff in jumping from a burning building, near the corner of Washington street and Sumner street, in Boston, on the night of November 10, 1872. The fire being alleged to have been caused by an explosion of gas through the defendant's negligence.

Butcher *vs.* Providence Gas Company, 1878, 12 R. I. 149.

Action for injury to plants :

Plants, in the plaintiff's greenhouse, which was connected with the public sewers, were injured by illuminating gas which escaped from the mains of the gas company, the defendant, into the sewers and thence found its way to the greenhouse and other greenhouses connected with the same sewers. It appeared that when the sewers were built by the city of Providence the earth was not properly packed, and the subsequent settling opened a leak in the gas pipes which caused the injury complained of.

Actions for injury to property from escape and explosion of illuminating gas.

Holden *vs.* the Liverpool New Gas and Coke Company, 3 Com. B. 1, 1844.

Escape of Gas—Explosion and damage to house.

The gas was supposed to escape from the internal supply pipe which had been torn or cut from the metre. It was in evidence that the occupier of the adjoining house smelling gas on his premises went to the cellar for the purpose of turning off his own supply, having a lighted candle with him, and that the explosion in the plantiff's house took place at that instant.

Blenkiron *vs.* Great Central Gas Consumers' Company, 2 Fost. & Fin., 437, 1860.

Escape from contiguous premises, explosion, fire, damages to plaintiff's premises.

Burrows *vs.* Marsh Gas and Coke Company, 7 L. R. Ex. 96 (affg. L. R. 5 Ex. 67), 1872.

Explosion, defective service pipe, damages to premises and stock, May, 1869.

Lanigan *vs.* New York Gaslight Company, 71 N. Y. 29, 1870.

Escape, uncapped service pipe, explosion, damage to property.

Schermerhorn *vs.* Metropolitan Gaslight Company, 5 Daly, 144, 1872.

Fractured service pipe, escape in cellar, explosion, damage to property.

Chisholm *vs.* Atlanta Gaslight Company, 57 Ga. 28, 1873.

Escape between service cock, under curb, and inside cock, explosion, damage to storehouse.

Bartlett *vs.* Boston Gaslight Co., 117 Mass., 533 and 122 Mass., 209.

Tort for injuries to the plaintiff's reversionary interest and estate in a house on Columbus avenue, Boston, caused by an explosion of gas.

1873. In consequence of a leak in the street pipe, the gas worked through the soil into the plaintiff's house, and the tenant smelling gas took a candle and went into the basement of the house, and on arriving there the gas ignited from the candle and the explosion took place, causing the damage for which the plaintiff now seeks to recover.

ACTIONS FOR NUISANCES FOR ESCAPE OF ILLUMINATING GAS.

Imperial Gaslight and Coke Co. *vs.* Broadbent, 7 H. L. Cases 600.

1856–59. Nuisance—Injunction.

Parry *vs.* Croydon Commercial Gas and Coke Co. 11 C. B. (N. S.) 578, aff'd Exch, Ch. 15 C. B. (N. S.) 568.

1861. Action by a common informer against defendant upon 10 G., 4 C. 73, for permitting offensive matter to flow into certain streams.

Hipkins *vs.* The Birmingham and Staffordshire Gaslight Co. 6 H. and N. 250.

1860. Escape of washings.

The gas tank was about sixty yards from the workings of a mine, in consequence of which the floor of the tank cracked. The washings in it flowed out and percolated to plaintiff's well, rendering the water in it unfit for domestic purposes.

Carhart *vs.* Auburn Gaslight Co. 22 Barb., 297.

1856. Corruption of water.

Pottstown Gas Co. *vs.* Murphy. 39 Penn. St, 257.

1856. Nuisance—Fouling well.

Brown *vs.* Illins. 27 Conn., 84. (See 25 Conn., 583.)

1856. Nuisance—Corrupting water.
Sherman *vs.* Fall River Iron Co. 5 Allen, 213. (See 2 Allen, 524).

1858–59. Nuisance—Fouling water.
Ottawa Gas Light and Coke Co. *vs.* Graham. 34 Ill., 346.

1864. Fouling well.
People *vs.* N. Y. Gaslight Co. 6 Lan., 467. 64 Barb., 45.

1872. Nuisance—Odors.

APPENDIX E. PAPER 22.

ILLUMINATING GAS IN ITS RELATIONS TO HEALTH.

By Edward S. Wood, M. D., Professor of Chemistry, Medical Department, Harvard University.

A Paper read at the Annual Meeting of American Public Health Association, Boston, October 5, 1876.

A brief description of the principles of gas manufacture.
(*a.*) Coal gas.
(*b.*) Water gas.
(*c.*) Petroleum gas.

Noxious constituents of the various kinds of illuminating gas. Injurious or offensive products evolved during the manufacture, purification and combustion of the gas.

In the limited time allotted, it will be impossible to give more than a brief description of the processes in the manufacture of illuminating gas, and only those will be referred to which have a bearing upon the sanitary question before us.

Illuminating gas is made almost exclusively from bituminous coal. For this purpose, bituminous coal is distilled in a closed retort, and evolves certain gases and vapors, some of which are combustible, and some, like steam are condensable, a residue of coke being left behind. This process is the most important of the operations in making coal gas, and also appears to have the

greatest influence upon the health of those employed in the works. But, in addition to this, it is necessary, before the gas is delivered to the holder, to remove from it those vapors which can be condensed, such as tar, water, &c., and also those non-condensable gases which either diminish largely the illuminating power if left in the gas, such as carbonic acid or which, when the gas is burned give rise to products of combustion which are injurious, such as sulphuretted hydrogen and ammonia. The removal of these necessitates two other operations—condensation and purification, the latter of which may or may not prove a nuisance to the whole neighborhood of the works, according as it is done properly or not.

First, as to the distillation of coal. This is performed in iron or clay retorts, three, five, six or seven of which, according to circumstances, are heated with one fire of coke to a high temperature. From 160 to 200 lbs. of coal are usually introduced into the retort at a time, the lids closed and the operation allowed to continue uninterruptedly for four or four and a half hours. At the expiration of this time the retorts are opened, the hot coke raked out and a fresh charge of coal introduced. The coke is wheeled to some convenient place and quenched with water The men engaged in attending the retorts are very liable to become affected with more or less severe affections of the respiratory organs. Dr. Peterson, city physician of Copenhagen, has published the results of his researches respecting the maladies of the employees at the gas works of that city: "Of 338 cases treated, 200 were among the retort tenders; 266 of the cases were non-surgical, and of these, ninety-six were of chronic or severe affections of the respiratory organs; fifty of catarrhal dyspepsia; twenty-eight of general debility, with fever, and twenty-six rheumatic affections. The more serious respiratory affections in gas employees generally, arise from prolonged catarrh, and for the most part consist of symptoms of bronchitis and phthisis, and of these cases eleven per cent. were of persons possessing originally strong constitutions." There are two causes which contribute to this result. First, the exposure to very great variations of temperature. The top of the retort house is always open in order to permit the escape of the products of combustion from the fires, and in most places the sides of the retort house are entirely open or contain large doors at short distances from each other, through which the coal may be brought and the hot coke wheeled away. This condition of things occasions, necessarily, draughts and

excessive changes of temperature in the winter season. In addition to this, it appears probable that the coal and coke dust add somewhat to the catarrhal affections of the respiratory organs.

The gas passes from the retort through the hydraulic main to the condenser, thence to the washers, where most of the ammonia is removed, and finally to the purifiers where those noxious substances, not removed by the condenser and washer, are taken away from it. These substances are chiefly carbonic acid and sulphuretted hydrogen. The objection to carbonic acid in gas is, that it lowers the illuminating power very greatly. The sulphuretted hydrogen and other gaseous sulphur compounds are injurious by giving rise in burning to sulphurous and sulphuric acids which may injure delicate structures, such as books, gilding, silks, &c., that may be exposed to the air of a room in which gas is burned. There is quite a difference of opinion among scientific men as to the injurious effects of sulphur in illuminating gas, but the weight of evidence appears to me to be greatly in favor of the statements of those who maintain that it is very injurious and should be removed from gas as thoroughly as possible. Where large quantities of impure gas are burned it causes a rapid destruction of textile fabrics with a very acid condition of them. This was especially noticed in the large public libraries in London many years ago, the covers of many of the books in the Athenæum Club House, the College of Surgeons and elsewhere, becoming destroyed by the sulphuric acid from the burning gas. The amount of this acid was so great that it could be easily tasted by applying the exposed portions of the books to the tongue. Plants are quickly killed by the products of burning gas, since they are peculiarly susceptible of injury from the presence of sulphurous acid in the air. According to Drs. Christison and Farmer, as little as one part in 10,000 of air will kill plants in less than twenty-four hours, and you cannot use gas in a conservatory either for heating or for illuminating purposes unless the products of combustion are entirely removed.

According to Mr. Chas. Heisch, superintending gas examiner to the corporation of the city of London, when sulphur is burned in a moist atmosphere (as is always the case with illuminating gas), the amount of sulphurous acid formed is quite insignificant, nearly all of the sulphur being converted into sulphuric acid, which is a vapor readily condensed on the walls of, and articles contained, in a room. Each grain of sulphur, in burning as it does in gas, gives rise to the production of just over three grains

of sulphuric acid. One hundred cubic feet of gas, if they contain thirty grains of sulphur (a very common amount) would in burning produce ninety grains of sulphuric acid ; and three burners, each burning four feet per hour, would produce between three and four grains of sulphuric acid per hour, or about twenty grains in six hours, which would in great part be condensed on the contents of the room in which the gas is burned. One very striking instance in proof of the above is given : "Some years since gas was introduced at the Royal Observatory in place of camphene lamps, for the photographic registration of magnetic variations, &c. In a very short time the surface of every reflector was destroyed, and the draw tubes of the telescopes quite corroded. It was found necessary to place a tube over each burner and to connect all of these with a central chimney, in which a strong draught was maintained to carry off the products of combustion. These tubes were, for cheapness, made of zinc. In a few days all of the lamps were found extinguished by a crystalline substance which dropped on the burners from the tubes. This proved to be sulphate of zinc. To prevent this a contrivance was resorted to by which the condensed matter was run into a vessel at the side of the chimney, and in one of these vessels there was collected in six weeks, from a burner consuming only about a half foot per hour, three quarters of a pound of sulphate of zinc."—London Journal of Gaslighting, December 29, 1874, page 856.

It is impossible to remove the sulphur entirely from gas, but nearly all of it may be got rid of. The English law requires that gas shall be absolutely free from sulphuretted hydrogen, and that the amount of sulphur in other forms of combination shall not exceed twenty grains (or in some works twenty-five grains), per one hundred cubic feet.

To remove the sulpuretted hydrogen, carbonic acid, &c., several methods are in use, the materials used being lime and oxide of iron. Lime is used both in the wet and dry way. The wet lime process consists in passing the gas through milk of lime. This effectually removes the carbonic acid, uniting with it to form chalk, and takes away most of the sulphur compounds by uniting with them to form calcic sulphide or sulphocarbonate. The wet lime is, however, very objectionable on account of the foul odor evolved from it when removed from the purifier, so that exclusive purification by wet lime has been generally abandoned. The dry lime process consists in passing gas through moistened slaked

lime placed upon trays. This is about as effective as the wet lime process, and is generally used in this country, but has been largely complained of as a nuisance where the works are situated in thickly settled districts, on account of the noxious and offensive odors evolved from the lime when removed from the trays, so that in New York city the companies have been compelled by the Board of Health either to resort to special apparatus for ventilating the lime and consuming these gases, or to use the iron oxide mixture for purification. In this city (Boston), a combination of the wet and dry lime processes is used. The wet lime, through which the gas is first passed and which retains most of the foul gases, is drawn from the purifier through a series of boxes and settling basins before the water finally comes into contact with the air, when there is but little stench arising from it; and the dry lime, when spent and removed from the purifiers, has no unpleasant odor.

The iron process never creates a nuisance. This consists in passing the gas through some mixture containing sesquihydrate of iron. The great advantage of this is its cheapness, since the same mixture may be used over and over again. The sulphuretted hydrogen in the gas reduces the sesquihydrate of iron to form water sulphur and hydrated sulphide of iron, which last, on exposure to the air, is changed again to sesquihydrate of iron, and more sulphur is set free. This process is adopted very extensively in the European works on account of its economy.

The difference between the action of the lime and that of the iron mixture appears to be chiefly that while the lime removes from the gas the impurities which it contains, perhaps better han the iron mixtures, yet, upon the opening of the purifiers, t permits the offensive and noxious sulphurous gases, like sulphide of ammonium, to escape into the atmosphere, become diffused throughout the neighborhood and act as a nuisance much more readily than the iron purifier does, which fixes the sulphur by combining with it. So that, where works are situated in thickly settled districts, the principal portion of the noxious constituents of the gas should be removed by wet lime before the gas passes through the dry lime, as in this city, and the "blue billy," as the wet lime residue is called, disposed of in such a manner as not to become a nuisance; or the dry lime should be thoroughly ventilated before the purifying boxes are opened, or recourse should be had to the iron mixture.

Gas thus made consists chiefly of hydrogen (40 to 50 per cent.), marsh gas (35 to 45 per cent.), carbonic oxide ($4\frac{1}{2}$ to $7\frac{6}{1}$ per cent.), olefiant gas and other hydrocarbons (4 to 8 per cent.), and usually very small amounts of carbonic acid and air. Cannel gas has about the same composition, the proportion of the hydrogen, marsh gas and olefiant gas being a little different.

Gas made from petroleum or naphtha need not occupy our attention, although it is made quite extensively in many of our large cities for enriching purposes, since, when made from Pennsylvania petroleum, it contains no sulphur or ammonia and requires no purification; and I have heard it stated, by those familiar with it, that the pure petroleum or naphtha gas can be inhaled with as much impunity as nitrous oxide, the symptoms produced being quite similar. By naphtha gas I do not mean such gas as is made in gasoline machines, but gas made by decomposing the naphtha in heated retorts.

Water Gas.—There is still another variety of gas which is becoming quite rapidly introduced into many smaller towns, and which requires our careful consideration. I refer to the so-called water gas. The theory of the manufacture of this gas differs entirely from that of coal or naphtha gas. It depends, first, upon the production of a non-illuminating gas from steam; and secondly, upon the manufacture of petroleum, naphtha or cannel gas, for the purpose of furnishing the luminants. The great advantage of this process is, that very large volumes of non-luminous combustible gas can be made very cheaply. This is done by passing steam over incandescent carbon, which has a very powerful attraction for oxygen, abstracts it from the steam, and unites with it to form at first a mixture of hydrogen and carbonic acid. The carbonic acid is, on passing through another layer of coal, deprived of one half of its oxygen, and carbonic oxide is formed. Thus we have as the result, if the process has been properly conducted, a mixture of hydrogen and carbonic oxide, both of which gases are combustible but burn with a colorless flame.

In making water gas, anthracite, not bituminous, coal is used, and great care is necessary to keep the temperature up to a white heat, since if it falls too low, a large proportion of carbonic acid is formed, which diminishes the yield of the finished gas, since it must be removed by purification, or if it is not removed it injures the illuminating power very much. Anthracite coal contains sulphur and yields ammonia when distilled, so that purification

is as necessary in the case of water gas as of coal gas. Water gas as thus made contains, as a rule, about forty to fifty per cent. of hydrogen, thirty to forty per cent. of carbonic oxide and about ten per cent. of petroleum or naphtha gas.

Strenuous efforts are of course being made by the owners of the various patent processes for making water gas to have it introduced into our large cities, and they advance as one of their strong arguments, the fact that the non luminous gas alone can be distributed for heating purposes at a cost of only a few cents per thousand feet. But the distribution of this mixture of hydrogen and carbonic oxide alone for heating purposes should be opposed in every possible way, for the reason that since it is comparatively devoid of odor its escape from pipes and diffusion through the air of an inhabited room in dangerous amount could not be detected. This mixture contains nearly fifty per cent. of carbonic oxide, which is one of the most active of poisons, producing when inhaled speedy death, and according to Leblanc, "one volume of it diffused through 100 volumes of air totally unfits it to sustain life; and it appears that the lamentable accidents which too frequently occur from burning charcoal or coke in braziers or chafing dishes in close rooms, result from the poisonous effects of the small quantity of carbonic oxide which is produced and escapes combustion, since the amount of carbonic acid thus diffused through the air is not sufficient in many cases to account for the fatal result."—Bloxam's Chemistry, page 118.

When it was proposed to supply the "Invalides" in Paris with water gas a commission was appointed consisting of Messrs. Dumas, Chevreul and Regnault, eminent chemists, to investigate it. They found that it contained from thirty to forty per cent. of carbonic oxide and reported "that it would be dangerous to the occupants of the institution to introduce, even by way of experiment, gas obtained from the decomposition of water by the Kirkham process."—London Journal of Gaslighting, June 10, 1856. [This gas was the odorless carbonic oxide and hydrogen mixture.]

H. Letheby says (London "Journal of Gaslighting," May 20, 1862): "Selligue, in 1840, obtained permission to use the gas in the towns of Dijon, Strasburg, Antwerp and two of the faubourgs of Paris and Lyons. At Strasburg an accident occurred which put a stop to its use. The gas escaped from the pipes into a baker's shop, and was fatal to several persons; and not long after an aeronaut, named Delcourt, incautiously used the gas for

inflating his balloon. He became insensible in the car, and those who approached to render him assistance fainted and fell likewise. The use of the gas has therefore been interdicted on the continent."

It is a somewhat significant fact that, although the manufacture of water gas for illuminating purposes on a large scale has been subjected to investigation, experiment and trial for more than twenty years in Europe, none of the large European companies have adopted it. It does appear, however, to have been much more successful in this country than in Europe, probably on account of the introduction of petroleum, which affords a cheap and adequate means of enriching it with luminants. Formerly the illuminating power was obtained by introducing into the non luminous flame, metallic platinum, or by mixing the water gas with rich gas obtained from peat, rosin or other carboniferous material. The above remarks in regard to the danger of water gas apply especially, if not only, to the odorless non-luminous gas. The addition to it of petroleum gas very greatly diminishes the danger by imparting to it a very powerful odor, and also dilutes slightly the carbonic oxide. No accidents have, so far as I have been informed, yet occurred in those works in this country where water gas has been manufactured. It is especially against the comparatively odorless gas for heating purposes that we should be upon our guard.

Experimentally, carbonic oxide can be removed by heating to a high temperature in contact with an excess of steam ; but that this is accomplished in any of the processes used for making water gas upon a large scale, I am unable to say. This is more likely to be accomplished in what is known as the Lowe process (Manayunk), than in any of the other, since an excess of steam passes with the gas from the furnace or generator through a chamber filled with white hot fire brick called a superheater or fixer. The carbonic oxide is not destroyed in the Harkness process (which was in use in New London, Conn., but which has been discontinued recently on account of the high price of petroleum), as more than forty per cent. was found by eudiometric analysis. About thirty per cent. of carbonic oxide was found in the pure water gas made by the Gwynne–Harris process, which is now in use in Poughkeepsie, N. Y. Ordinary coal gas has, as I have already mentioned, usually from five to seven per cent. of carbonic oxide.

From a sanitary point of view, therefore, the principal points to be borne in mind, and to be obviated if possible, are: (1) the exposure of the workmen to excessive changes of temperature and violent draughts of air while heated; (2) to remove from the gas the noxious impurities and those which on burning give rise to noxious products of combustion as completely and thoroughly as possible, and at the same time dispose of the purifying material in such a manner as not to create a nuisance; and (3) to prevent the introduction of the dangerous inodorous mixture of hydrogen and carbonic oxide for heating purposes. I have dwelt somewhat at length upon this last subject, because the manufacture of water gas appears to be attracting the serious attention of many gas engineers at the present time, and works are now in operation manufacturing from 50,000 to 150,000 cubic feet per day each. The mixture of water gas with cannel or petroleum gas appears, however, practically to be but little if any more dangerous than common coal gas.

[From Volume III. of the American Public Health Association reports.]

BIBLIOGRAPHY OF WATER GAS.

COMMUNICATED BY MR. THOMAS B. FOGARTY, WITH NOTES THEREON BY HIM

1. Historical Notice of Lighting by Water Gas.—See Genie Industriel, vol. 11, page 148. Can be seen at Astor Library.

   The only bearing of this article on the subject is the record of water gas having been made free from carbonic oxide on a practical scale.

2. Poisonous Effects of Carbonic Oxide.—A very strong paper by Dr. Letheby, of London. American Gaslight Journal, vol. 4, page 6, July 1st, 1862; also, London Journal of Gas-lighting, vol. 11, page 335, May 20th, 1862.

   Dr. Letheby was for more than twenty years gas chemist to the city of London.

3. Carbonic Acid and Carbonic Oxide as Poisons.—American Gaslight Journal, vol. 16, page 115, April 2d, 1872.

   I have made no note of the writer.

4. Carbonic Oxide, Poisoned by—Horrible Accident.—American Gaslight Journal, vol. 18, page 169, May 16th, 1873.

5. Report made by the Gas Commissioners to the City of Boston, Mass., October, 1876.—City Document No. 9. Commissioners, Charles F. Choate, John F. Osgood, Edward S. Wood. Correspondence to be addressed to Edward S. Wood, M.D., Harvard Medical School, Boston, Mass.

This is a most exhaustive and voluminous report, but does not contain much on the subject of carbonic oxide.

The entire report was republished in the London Journal of Gaslighting. That part relating to carbonic oxide will be found in vol. 29, page 351, March 6th, 1877.

6. Lengthy Extract from the Report of M. Pelouze, Professor of Chemistry and Member of the French Institute, to the Municipal Council of Paris, at their sittings of June 24th and 28th, 1854, wherein he condemns the gas of M. Selligue on account of the large percentage of carbonic oxide it contained, and describes the prostration of M. Delcourt and of several persons who ran to his assistance through the escape of gas from a balloon.—London Gaslight Journal, vol. 3, page 529, September 11th, 1854.

7. This is a paper giving the whole story of an attempt to introduce another form of water gas into Paris.—London Gaslight Journal, vol. 5, page 334, June 10th, 1856.

8. Prof. Henry Wurtz's report upon Water Gas to the Municipal Gaslight Company of New York, in favor of the gas.—London Gaslight Journal, vol. 31, page 722, May 7th, 1878.

9. Water Gas, A Series of Articles on.—Chiefly descriptive of the various processes in use in the United States and apparently in reply to Wurtz's report, pages 831, 908, 943, 979 of the 31st vol. and page 87 of vol. 32 of the London Gaslight Journal.

In a sanitary view the chief interest in these papers is in the reply by a French chemist to Pelouze's report to the Paris Municipality, to be found at page 908, vol. 31.

10. In an editorial in the London Journal of Gaslighting, page 498, vol. 22, will be found a long series of references of articles on the poisonous qualities of carbonic oxide.

11. Paper on the Poisonous Effects of Carbonic Oxide, by Dr. Van der Meyde, of New York.—American Journal of Gaslighting, vol. 20, page 61, February 16th, 1874.

12. Address delivered by Prof. Chandler before the American Gaslight Association, at their Third annual meeting, October 2d, 1875.—American Gaslight Journal, vol. 24, page 9, (middle column), issue of January 3d, 1876; also, page 119, vol. 2, of the reports of the association.

Mr. Chandler here makes a statement which, if true, and my experience satisfies me that it is so, fully accounts for the great number of accidents from the use of water gas, viz.: "That gas containing much carbonic oxide is very easily extinguished by draughts of air," which would lead to the supposition that accidents which are supposed to occur in consequence of the gas being blown out before going to bed really occur through its being left lighted, and becoming extinguished during the night.

13. Carbonic Oxide in Illuminating Gas.—American Journal of Gaslighting. vol. 27, page 244, December 17th, 1877.

This article is a commentary on a paper in the same number by Robert Briggs in which he endeavors to show, among other things, that carbonic acid is perfectly harmless. The editorial takes strong ground upon the other side and quotes many authorities.

14. Carbonic Oxide.—Is it a Harmless Anæsthetic or a Virulent Poison? A paper by Prof. Henry Morton, of the Stevens Institute. American Journal of Gaslighting, vol. 28, pages 90 and 112, March 2d and 16th, 1878.

This is a most important paper, and goes most fully into the whole question. It quotes a great number of authorities, and takes strong ground against the use of any gas containing a large percentage of carbonic oxide on account of the poisonous qualities of the latter.

15. Carbonic Oxide.—Is it a Virulent Poison? Qualified language. By Robert Briggs, Jr. American Journal of Gaslighting, vol. 28, page 157, April 16th, 1878.

This article is meant to be a reply to Prof. Morton's paper.

16. On some New Contributions to the Chemical and Technical History of Coal Gas. By Alfred E. Anderson, Professor of Practical Chemistry at Queens' College, Birmingham, England.—American Journal of Gaslighting, vol. 28, page 190, May 2d, 1878.

The remarkable point in this paper, as regards carbonic oxide, is that he proves experimentally that so far from being classed as a "diluent" in coal gas, as it usually is, carbonic oxide should be regarded as a most noxious impurity, as, independently of its poisonous qualities, the presence of a large percentage of carbonic oxide in illuminating gas is very destructive of its illuminating powers.

17. Absorption of Carbonic Oxide by Living Organisms.—American Journal of Gaslighting, vol. 29, page 251, December 2d, 1878.

The above is a notice of a paper on the subject by M. N. Grehaut, in "Comptes Rendues."

18. Suffocation by Water Gas.—American Journal of Gaslighting, vol. 33, page 11, July 2d, 1880.

A letter upon the poisonous qualities of water gas. The authorities quoted are mostly those already mentioned.

19. Carbonic Oxide in Water Gas.—American Journal of Gaslighting, vol. 33, page 36, July 16th, 1880.

This is merely a letter stating that T. du Motay, under whose patents the Municipal Company is working, was fully aware of the dangerous character of the gas and was making efforts to remedy it.

20. Carbonic Oxide at Toronto.—American Journal of Gaslighting, vol. 34, pages 33 and 77, January 17th and February 16th, 1881.

These papers contain very damaging reports about the water gas at Toronto. Many authorities are quoted and facts given—some of them new.

21. Anthracite and Health (giving the effects of carbonic oxide), by George Derby, M. D., University lecturer on hygiene in Harvard University. 12mo. Published by A Williams & Co, Boston, 1868.

POSTSCRIPT.

November 9, 1883.

In accordance with the request of the Committee on Lamps and Gas of the Board of Aldermen of the city of Brooklyn, the body of this report, not including the appendix, was submitted to Professor Ira Remsen, whose report as consulting chemist appears in this report at pages 5 and 6, with a request to read it and to inform the Commissioner of Health if the evidence therein contained modified his views as expressed in his written opinion above referred to. To this request the following reply was made by Professor Remsen :

JOHNS HOPKINS UNIVERSITY,
Chemical Laboratory,
BALTIMORE, MD., October 29, 1883.

J. H. RAYMOND, M. D., *Commissioner of Health. Brooklyn, N. Y.* :

DEAR SIR :

I have examined the advanced sheets of your report kindly sent to me a few days since. I see no reason for materially changing the opinion expressed by me in my letter dated May 8, 1883. On one point I ought perhaps to express myself somewhat more distinctly. I referred to the odors of the two kinds of gas as being equally bad. I have never smelt either coal gas or water gas that did not have a very disagreeable odor. As an indicator of the escape of gas this odor is, of course, very desirable. Should either coal gas or water gas be manufactured without this odor, I should regard its use as dangerous. Now whether water gas has ever been made or is now made without the bad odor I do not know. In any legislation on the subject, I should think that, so far as danger to health is concerned, special attention should be given to the question of the odor. An inodorous gas containing carbonic oxide, whether one or thirty per cent, would, in my opinion, be a very dangerous thing.

As regards the statistics collected by you with such care, I can only say that they require very careful interpretation. I do not see how any conclusion can be drawn from them with regard to the relative danger attending the use of the two kinds of gas.

Yours respectfully,

IRA REMSEN.

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